

CIRCULATE

Vol. 1

30 IX 1949

No. 3

HYDROBIOLOGIA

ACTA HYDROBIOLOGICA, LIMNOLOGICA ET PROTISTOLOGICA

NOV 17 49

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Einige Gedanken zur Frage des Nährstoffhaushalts der Gewässer

Von: Prof. R. MAUCHA, Budapest

Ein See kann als höhere biologische Einheit für einen *Holos* angesehen werden, in welchem das biologische Geschehen im dreidimensionalen Raum und Zeit vor sich geht. Eine jede Organisation dieser Art wird nach K. FRIEDERICHS (1937) *Holocön* genannt. Die charakteristische Eigenschaft eines *Holocöns* ist die *Autarkie*. Nun gibt es auf der Erde nur ein einziges ideales *Holocön*, die gesamte *Biosphäre*, da die *Autarkie* nur dort restlos durchgeführt wird. Sämtliche übrigen bekannten Einzel*holocöne* sind nur unvollkommen geschlossen, deswegen beeinflussen sie sich gegenseitig und darum können diese als vollständig unabhängige Lebensräume nicht behandelt werden. Als bestgeschlossenes *Holocön* unter allen bekannten dürfte gewiss ein See betrachtet werden, obwohl auch dieser kein ideales *Holocön* darstellt, indem er von den benachbarten Festland-*Holocönen* ebenso abhängig ist, wie die letztgenannten von einem See beeinflusst werden. Doch wird die *Autarkie* unter allen irdischen *Holocönen* in einem See am engsten angenähert. Deswegen hat Verfasser (1943) in Vorschlag gebracht, die Einzel*holocöne*, wie z.B. einen Wald, eine Wiese, eine Grotte, einen See, u.s.w. nur als *holocön-artige* höhere biologische Einheiten aufzufassen und diese mit dem Namen *Holocönoid* zu bezeichnen.

Ein *Holocönoid* ist demnach *eine, aus mehr oder weniger gut begrenztem Lebensraum und Lebensgemeinschaft zusammengesetzte höhere biologische Organisation, in der das in dreidimensionalem Raum und Zeit vor sich gehende biologische Geschehen die Autarkie nur mit einer kleineren oder grösseren Annäherung verwirklichen lässt, aber niemals vollkommen zu Stande bringt.*

Wie der Verfasser an anderen Stellen (1943, 1943a) öfters dargelegt hat, kann das biologische Geschehen, — sei dieses noch so verwickelt — stets auf den einfachen Redoxkreisprozess:

$$6 \text{ CO}_2 + 5 \text{ H}_2\text{O} + 685,000 \text{ cal} \rightleftharpoons \text{C}_6\text{H}_{10}\text{O}_5 + 6 \text{ O}_2$$
zurückgeführt werden. Dieser Kreisprozess wird von den physiologisch und ökologisch scharf abgesonderten drei Gruppen der Biocönosensbevölkerung, *Produzenten*, *Konsumenten* und *Reduzenten* im Gange gehalten. Der in der angeführten Gleichung im Sinne des oberen Pfeiles vor sich gehende Reduktionsprozess wird von den Produzenten und zwar durch die Chlorophyllfüh-

reneden, sich autotroph ernährenden Organismen aufrecht erhalten. Wir wissen aber, dass die ersten Produkte dabei ausnahmslos immer stickstofffreie organische Verbindungen, also Kohlenhydrate (Stärke, Paramylum, Dextrose) oder hie und da Fette (Diatomeen) sind. Stickstoffhaltige organische Substanzen, wie Aminosäuren oder Proteine werden aber unmittelbar durch Spaltung des Kohlendioxids von den Produzenten niemals dargestellt. Wie wir gleich sehen werden, ist das in produktionsbiologischer Hinsicht sehr wichtig.

Wie auf jeden, ist auch für diesen Kreisprozess das Gesetz der freien Energie gültig. Dieser Satz sagt aus, dass die Änderung des Energiegehaltes eines Systems während des Kreisprozesses nur von dem Anfangs- und Endzustande bedingt wird, von dem Wege aber, auf welchem der Umsatz sich vollzieht, vollkommen unabhängig ist. Daraus folgt, dass, obwohl im Holocönoid neben den autotroph erzeugten Kohlenhydraten auch noch andere organische Verbindungen, ja sogar solche mit höherem potentiellen Energiegehalt, wie z.B. Eiweisstoffe entstehen, der Energiegehalt des ganzen Systems dadurch doch nicht gesteigert wird, weil dabei kein CO_2 zur Spaltung kommt und kein O_2 entbunden wird.

Nachdem die Zustandsanzeiger des Systems die Konzentrationen des ausnutzbaren CO_2 als Ausgangsstoffs und des gelösten O_2 als Endprodukts sind, zeigt die Änderung der Konzentration dieser Bestandteile des Wassers während des Kreisprozesses eindeutig und restlos den Energieumsatz des Systems, also zugleich die Produktionsgrösse des Holocönoids an. Darum gelang es A. THIENEMANN die Seen bloss auf Grund der O_2 Schichtung des Hypolimnions in gut definierte produktionsbiologische Typen einzuteilen. Deswegen ist auch der O_2 Gradient des Verfassers (1930, 1932) zur Charakterisierung des Trophiezustandes der Seen geeignet. Das steht auch auf dem CO_2 Gradient von W. OHLE (1938), dem es ebenfalls gelungen ist auf Grund des CO_2 Gehaltes im Wasser die norddeutschen Seen in produktionsbiologischen Typen einzuteilen.

Alle Versuche hingegen, die bis jetzt ohne Berücksichtigung des CO_2 Gehaltes, sich nur auf den Stickstoff- oder Phosphatgehalt des Wassers stützten, führten auf negative oder mindestens auf widersprüchliche Ergebnisse. Wir verweisen hier auf die vorzüglichen Erörterungen von L. MINDER (1926).

Der Stickstoffgehalt des Wassers und die gleichzeitige Produktion organischer Verbindungen durch Photosynthese stehen nach MINDERS einwandfreien Feststellungen mit einander in keinem kausalen Verhältniss. Bei seinen Untersuchungen am Zürichsee hat MINDER (1926) nur im Frühjahr eine Parallelität beobachtet, im Spätsommer, etwa zu Ende August, konnte er aber einen Aufschwung der photosynthetischen Tätigkeit nachweisen ohne dass zugleich das Vorhandensein von elektrolytischen Stickstoffverbindungen nachgewiesen werden konnte. MINDER vermutete, dass

die zu dieser Zeit schon eintretende Sommerteilzirkulation des Wassers aus den grösseren Tiefen des Sees Stickstoffverbindungen den Produzenten zur Verfügung gestellt hätte und dass diese sofort dem Wasser entzogen würden, da diese nicht nachweisbar waren.

Aus B. HOFERS (1915) Teichdüngungsversuchen wissen wir, dass die Wasserproduzenten während ihrer Assimilationstätigkeit die Stickstoffverbindungen äusserst gierig aufnehmen, so dass diese binnen kurzer Zeit dem Wasser entzogen sind. Dasselbe wurde durch unsere eigene Beobachtungen in der Teichwirtschaft zu Pellérd in Südungarn bestätigt. Die Teiche dieser Teichwirtschaft werden durch einen kleinen mit Abwässern stark belasteten Vorfluter gespeist. Das Wasser dieses Vorfluters enthält stets grosse Mengen von anorganischen Stickstoffverbindungen, neben NO'_2 und NO'_3 besonders H_3N , etwa 80 mg im Liter. Im Winter, wenn die photosynthetische Tätigkeit der Produzenten minimal wird, enthält das Wasser der Teiche nach unseren vieljährigen Beobachtungen 15—20 mg H_3N im Liter. Zugleich konnte auch das Vorhandensein von NO'_2 und NO'_3 nachgewiesen werden. In Sommer hingegen, zur Zeit einer kolossalen Hochproduktion in den Fischteichen, was durch eine starke Vegetationsfärbung des Wassers angedeutet war, gelang es niemals, Stickstoffverbindungen in den Teichen sogar in Spuren nachzuweisen, obwohl im Wasser des speisenden Vorfluters stets ein etwa 80 mg/l ausmachender H_3N Gehalt feststellbar war. Es ist also klar, dass die produzierenden Algen die Stickstoffverbindungen des Wassers während des Sommers gierig entzogen haben.

Aus diesen Beobachtungen geht hervor, dass der Stickstoffgehalt des Wassers und die Produktionsfähigkeit der Gewässer in vielen Fällen in verkehrtem Verhältniss zu einander stehen. Von einem hohen Stickstoffgehalt kann demnach durchaus nicht auf eine grosse und umgekehrt aus dem Fehlen von elektrolytischen Stickstoffverbindungen auf eine schwache Produktionsfähigkeit eines Gewässers geschlossen werden.

Die Ursache, dass man die produktionsbiologische Verhältnisse der Seen noch immer ohne Berücksichtigung des CO_2 Gehaltes, bloss aus der Konzentration der übrigen Pflanzennährstoffe, wie N, P, S, K, u. s. w. festzustellen sucht, dürfte nach unserer Vermutung jedenfalls *die grosse Wirkung* von J. LIEBIGS epochenmachenden Erfolgen auf dem Gebiete der Landwirtschaftlichen Chemie sein, wovon man sich nicht so leicht losreissen kann. Die Gesetzmässigkeiten, welche LIEBIG für die landwirtschaftliche Produktion festgestellt hat, dürften doch *nicht* ohne weiteres auf den limnischen Lebensraum übertragen werden, da ja prinzipiell tiefgreifende Unterschiede zwischen beiden Produktionsgebieten bestehen. Bis nämlich der Landwirt eine gewisse Nutzpflanze auf seinem Boden möglichst rein und in grösster Menge erzeugt, wozu er die Bedingungen selbst bestimmt, verteilt sich die Produktion des

fähigkeit von Gewässern die Konzentrationsänderungen des gelösten Sauerstoffs, oder des ausnutzbaren CO_2 Gehaltes vollkommen ausreichen, weil allein deren Konzentrationen als *Zustandsanzeiger* des rückläufigen Redoxkreisprozesses gelten. Dass dabei von den Produzenten, Konsumenten ja sogar auch von den Reduzenten auf Kosten des freien Energievorrats der autotroph erzeugten stickstofffreien organischen Verbindungen Proteine aufgebaut werden, hat mit der Produktionsfähigkeit des Holocönoids gar nichts zu tun, weil durch das Entstehen von Proteinen weder CO_2 gespalten, noch O_2 entbunden, in Folge dessen der freie Energievorrat des Holocönoids nicht vergrößert, weiterhin entsprechend des freien Energie-Satzes, der Anfangs- und Endzustand des Systems auch nicht beeinflusst wird.

Gelang es nun A. THIENEMANN bloss auf Grund der Sauerstoffschichtung des Hypolimnions die Seen in produktionsbiologisch gut definierte Typen einzureihen, versuchen wir jetzt dasselbe auf Grund des ausnutzbaren CO_2 Gehaltes durchzuführen. Es ist einleuchtend, dass abgesehen von den oben erwähnten Erfolgen W. OHLE's mit dem CO_2 Gradienten, dies auch schon darum gelingen dürfte, weil zwischen den O_2 und CO_2 Schichtungskurven der Seen, laut der bisher erhaltenen zahlreichen Versuchsergebnisse, eine gut wahrnehmbare Reziprozität besteht. Überwiegen in einer Wasserschicht die photosynthetischen Vorgänge, so wird dort in Folge der CO_2 Spaltung CO_2 verbraucht und O_2 aufgespeichert, im Gegensatz zu einer Schicht, wo der Abbau die Oberhand besitzt und deswegen O_2 verbraucht und CO_2 gebildet wird. Ist also der Sauerstoffgehalt des Wassers für die Produktionsfähigkeit eines Gewässers massgebend, so muss auch die Änderung der Konzentration des ausnutzbaren Kohlendioxyds darüber Aufschlüsse bieten. In Übereinstimmung mit MINDER betrachten wir als ausnützbare Kohlendioxyd die *freie* und die *Hälfte der Bikarbonat* — d.h. der sogenannten *halbgebundenen Kohlensäure*.

In dieser Hinsicht können die Gewässer in zwei gut unterscheidbare Gruppen bzw. *Typen* eingeteilt werden. Die Mehrzahl der Gewässer enthält ein Wasser mit freiem CO_2 Gehalt. Von sehr wenigen Ausnahmen abgesehen, wurden in der limnologischen Literatur bis jetzt nur solche Gewässer behandelt. Es gibt aber, besonders in *Ungarn*, recht viele Gewässer deren Wasser keine freie Kohlensäure enthält. Selbstverständlich kann in diesen Gewässern die freie Kohlensäure als ausnutzbare nicht in Betracht kommen. In diesen, meistens stark eutrophen Gewässern kann nur allein die Hälfte der Bikarbonatkohlensäure als ausnutzbar angesehen werden, eine Möglichkeit welche auch durch die Versuchsergebnisse des Verfassers (1929) bewiesen ist.

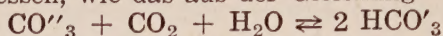
Aus hydrochemischen Gesichtspunkten ist zwischen diesen zwei Typen der Gewässer ein scharfen Unterschied feststellbar. In dem freien CO_2 enthaltenden Wasser besteht beinahe der ganze

limnischen Holocöns zwischen den verschiedensten Arten von Pflanzen und Tieren, welche eine Lebensgemeinschaft bilden, in der die physiologischen Prozesse sich das Gleichgewicht halten, also ohne menschlicher Einwirkung selbstregulatorisch vor sich gehen.

Die landwirtschaftlich gezüchteten Nutzpflanzen leben am Festlande und beziehen die Kohlensäure aus der *Atmosphäre*, die übrigen Nährstoffe aus dem *Boden*. Dagegen entnehmen die Produzenten des limnischen Lebensraumes *sämtliche Nährstoffe, auch die Kohlensäure von demselben Medium, nämlich vom Wasser*. Da der Kohlensäuregehalt der Luft wo immer auf der Erde eine konstante Grösse ist (0,03 %), die Menge der übrigen Nährstoffe hingegen im Boden recht grosse Schwankungen aufweist, ist es selbstverständlich, dass die Produktionsgrösse der landwirtschaftlich gezüchteten Nutzpflanzen nicht von dem konstanten Kohlensäuregehalt der Luft, sondern entsprechend des *Liebigschen* Minimumgesetzes von dem Pflanzennährstoff bedingt wird, welcher in *kleinster* Menge im Boden vorhanden ist. Dem gegenüber weist aber im limnischen Holocönoid auch die Konzentration der ausnutzbaren Kohlensäure und nicht nur der übrigen Nährstoffe grosse Schwankungen auf. Es ist also offenbar, dass die Produktionsfähigkeit der Gewässer in erster Linie von diesem allerwichtigsten Baustein der organischen Verbindungen beeinflusst wird, indem ja der Kohlenstoff in *bedeutend grösserem* Umfang am Aufbau derselben beteiligt ist (42—77 %) als z.B. der Stickstoff (16 %), der Schwefel (1—2 %), oder der Phosphor (einige zehntel Prozent). Also ohne die Berücksichtigung des CO₂ Gehaltes im Wasser, allein nur aus dem Stickstoff-, Schwefel- oder Phosphorgehalt, wie das in dem landwirtschaftlichen Betrieb ohne weiteres möglich ist, dürfte man doch nicht auf die Produktionsverhältnisse des limnischen Holozönoids Schlüsse ziehen können. Das limnische Holozönoid kann höchstens mit einem Festland Holozönoid verglichen werden, das ohne Eingreifen des Menschen sich mit seiner Gesamtbioönose ebenfalls selbstregulatorisch erhält, das z.B. durch einen Urwald, oder eine Urweide dargestellt ist. Die im Festlandholocönoid auch vorhandenen Reduzenten sorgen ja dafür, dass die einzelne Nährstoffe, also Stickstoff, Schwefel, Phosphor u.s.w. in genügenden Mengen und in unmittelbar verwertbarer Form den Produzenten ständig zur Verfügung stehen. Während dieser Umwandlung bleibt der Stickstoffvorrat des Holocönoids konstant, wenn auch ein Teil desselben durch die Tätigkeit der denitrifizierenden Bakterien, oder durch Auswandern einiger Gruppen der Biocönosensbevölkerung verloren geht. Dieser Teil wird durch die Stickstoffsammler Bakterien und durch Niederschläge aus der Atmosphäre ersetzt. (S. darüber MAUCHA, 1943a).

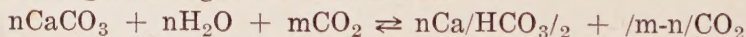
Aus diesen Betrachtungen geht hervor, dass zur Aufstellung von Trophiestandarden bzw. zur Feststellung der Produktions-

Salzgehalt aus Ca^{++} und HCO_3' Ionen. Das Wasser enthält niemals CO_3'' Ionen, weil diese und die freie Kohlensäure sich gegenseitig ausschliessen, wie das aus der Gleichung



hervorgeht. Freie CO_2 und CO_3'' Ionen benehmen sich in dieser Reaktion wie positive und negative Zahlen. Fasst man nämlich den freien als positiven CO_2 Gehalt auf, dann ist der CO_3'' Gehalt des Wassers als negative freie Kohlensäure zu behandeln, da diese sich zu HCO_3' Ionen ergänzen. Aus dem Gesichtspunkts des ausnutzbaren CO_2 Gehaltes können also die Gewässer in einen Typus mit *negativem* und einen mit *positivem* CO_2 Gehalt eingereiht werden. Der erste dieser Typen enthält stets CO_3'' Ionen, Ca^{++} Ionen aber nur höchsten soviel, als CaCO_3'' in Abwesenheit freier Kohlensäure überhaupt im Wasser löslich ist (etwa 13—14 mg/l. S. darüber auch MINDER 1926). Der Elektrolytengehalt dieser Gewässer setzt sich also nahezu ausschliesslich aus Na^+ , Mg^{++} , HCO_3' und CO_3'' Ionen zusammen. Zwischen HCO_3' und Na^+ Ionengehalt ist aber kein Gleichgewichtszustand nachweisbar. Überhaupt enthält das Wasser solcher Seen weitaus weniger Na^+ , HCO_3' und CO_3'' Ionen, dass man von einer gesättigten Lösung sprechen konnte. Es kann also von keinerlei chemischem Gleichgewichtszustand die Rede sein. Die Wasserstoffionenkonzentration in diesen Gewässern ist sehr klein, da der pH Wert des Wassers in Folge des CO_3'' Ionengehaltes stets grösser als 8,5 ist.

Das Wasser der in die andere Type gehörenden Gewässer ist hingegen als eine gesättigte Lösung von $\text{Ca}(\text{HCO}_3)_2$ aufzufassen, indem ja der überwiegende Teil des Elektrolytengehaltes aus Ca^{++} und HCO_3' Ionen sich zusammensetzt, zwischen welchen und dem freien Kohlensäuregehalt TILLMANS und HEUBLEIN (1912) das strenge Gleichgewichtsverhältniss



nachgewiesen haben, wonach n Grammäquivalenten von $\text{Ca}/\text{HCO}_3/2$ in Lösung gehalten werden, wenn dass Wasser zugleich auch noch /m-n/ Grammäquivalenten freie, die sogenannte *zugehörige*, oder *Gleichgewichts* Kohlensäure enthält. In diesen Gewässern wird der bikarbonat CO_2 Gehalt durch die Assimilationstätigkeit der Algen nicht direkt, sondern durch Vermittelung der freien Kohlensäure in Anspruch genommen. Wird nämlich bei der Assimilation CO_2 verbraucht, so muss die entsprechende Menge CO_2 durch Spaltung des HCO_3' Ions frei gemacht und CaCO_3 ausgeschieden werden. (Biogene Entkalkung der Seen. S. darüber die vorzüglichen Erörterungen von L. MINDER, 1923 und 1926). Der pH Wert dieser Gewässer bleibt immer unter 8,5.

Die Binnengewässer lassen sich also in Hinsicht ihrer ausnutzbaren CO_2 Gehalte in zwei Gruppen oder Typen einteilen und zwar in Gewässer mit negativen bzw. mit positivem CO_2 Gehalt. Dementsprechend wollen wir diese zwei Typen in ein einheitliches, sämtliche Gewässer, auch das Meerwasser umfas-

sendes System einteilen. Hält man sich dabei an JÄRNEFELT (1939), so lassen sich die Binnengewässer mit *negativem* CO_2 Gehalt in eine Gruppe die wir *α -limno Typus* nennen wollen und die mit *positivem* CO_2 Gehalt in die Gruppe *β -limno Typus* genannt, einreihen. Innerhalb dieser Typen lassen sich nachher, je nach dem die HCO_3 , SO''_4 , oder die Cl' Ionen das Übergewicht haben, Untertypen feststellen.

Um das zu verdeutlichen, führen wir die Bildertafel 1. an, wo die chemische Zusammensetzung einiger Gewässer nach der Methode des Verfassers (1932 und 1934) graphisch dargestellt ist. Aus dieser Tafel ist feststellbar, dass die Gewässer des *α -limno Typus* in die Järnefeltsche *α -limnohaline* und schliesslich in die rein *haline* Type des Meerwassers übergehen. Die Gewässer des *β -limno Typus* führen hingegen in den *β -limnohalinen* bzw. nachher ebenfalls in den *halinen Typus* über.

Die in Tafel 1. angeführten graphischen Darstellungen unterrichten uns aber nur von der *relativen* chemischen Zusammensetzung des Wassers, d.h. die einzelnen Abbildungen gestalten sich entsprechend der gegenseitigen Menge der verschiedenen Ionenarten. Sie geben deswegen ein charakteristisches Bild von der hydrochemischen Beschaffenheit eines Gewässers, sagen aber über die absoluten Mengen der einzelnen Ionenarten gar nichts aus. Wir beabsichtigen nun diese graphische Darstellung derart abzuändern, dass auch die absolute Menge des *ausnutzbaren Kohlendioxyds* ausgeprägt sei. Ist nämlich nach unserer Vermutung der ausnutzbare CO_2 Gehalt des Wassers in produktionsbiologischer Hinsicht ebenso massgebend, wie die Sauerstoffschichtung, dann müssen die graphischen Darstellungen auch über die Seeeutrophie Aufschlüsse geben. Um das zu beweisen versuchten wir die graphische Darstellung derart durchzuführen, dass wir die Flächengrösse der einzelnen Figuren *proportional dem ausnutzbaren CO_2 Gehalte* machten. Für die Gewässer des *α -limno Typus* ist nach dem vorher Gesagten die ausnutzbare Kohlensäure einfach dem *HCO'_3 Ionengehalt* proportional. In den Gewässern des *β -limno Typus* soll nun als ausnutzbare Kohlensäure die *Summe der freien zugehörigen und des halbgebundenen Anteiles der HCO'_3 Ionen* angesehen werden. Tabelle 1. enthält auf Grund der in der Literatur auffindlichen Analysenergebnisse berechnete Werte des halbgebundenen und die entsprechenden Mengen des freien zugehörigen Kohlendioxyds für eine Reihe gutbekannte Gewässer. Die Summe dieser Werte ist der ausnutzbare CO_2 Gehalt des betreffenden Wassers. Man dürfte also im Falle der dem *β -limno Typus* angehörigen Gewässer die Flächengrösse der einzelnen Figuren dieser Summe proportional machen. Das kann nun folgendermassen geschehen: (s. auch MAUCHA 1932 und 1934). Der Radius des zur Konstruktion der Figuren benutzten Ankreises für das Sechzehneck, von welchem die Darstellungen herbeigeleitet werden, lässt sich durch die Formel

$$R = \sqrt{\frac{H}{8 \sin 22,5^\circ}}$$

berechnen, wo H die Zahl der Milligrammäquivalenten des Literwertes der ausnutzbaren Kohlensäure bedeutet. Die auf die radialen Halbierungslinien der verschiedenen Ionensektoren auftragbaren Längen lassen sich durch die Gleichung

$$A = \frac{SH}{200} = 0,022861 S \sqrt{\frac{H}{8 \sin 22,5^\circ}}$$

berechnen, wenn S die Äquivalentprozentenzahl der verschiedenen Ionenarten bedeutet. Mit dieser Gleichung wurden die Figuren in Tafel 2. berechnet.

Aus diesen Figuren geht hervor, dass die Produktionsfähigkeit des dystrophen Sees „*Mohosláp*“ äusserst klein ist, indem die Fläche der Figur recht klein ausfiel. Es folgen nachher mit allmählich zunehmenden Flächengrössen oligotrophe Seen und zwar der Kratersee (ein Maar) „*Szent Anna tó*“, der *Genfer See*, der *Davoser See* und der *Lake Huron*, weiter die schwach eutrophen Seen, wie der *Grosser Plönersee* und der *Zürichsee*, nachher der eutrophe *Balatonsee* und zum Schluss die stark eutrophen Seen, der „*Belső tó*“ zu *Tihany* und der *Velenceese*.

Der Trophiegrad der einzelnen Seen wird durch die Fläche

$$H = \frac{16 R^2 \sin 22,5^\circ}{2} = 3,06144 \cdot R^2$$

dargestellt, wo R der Radius vom Ankreise des Zechzehneckes ist. Die Produktionsfähigkeit der Seen wird demnach durch die Grösse R^2 charakterisiert, welche Grösse ebenfalls der Konzentration des ausnutzbaren Kohlensäuregehaltes proportional ist. In Spalte 4 sind die Werte von R^2 angeführt. Aus diesen lässt sich entnehmen, dass der Wert von R^2 für dystrophe Gewässer unter etwa 0,05 bleibt. Für oligotrophe Gewässer schwankt dieser Wert zwischen 0,05 und 0,80, eutrophe Gewässer weisen einen Wert von R^2 auf, der oberhalb 0,80 liegt und bei dem α -limno Typus recht bedeutendes Grössen erreichen kann.

Auf Grund des ausnutzbaren Kohlensäuregehaltes lassen sich also durch Vermittelung der graphischen Darstellung der chemischen Zusammensetzung des Wassers Grenzwerte einführen, welche ermöglichen, dass man den Trophiegrad nicht nur bei tiefen, mit gut entwickeltem *Hypolimnion* versehenen Seen, sondern auch für fließende Gewässer mit genügender Genauigkeit ermitteln kann.

Zusammenfassend wird also in dieser Arbeit nachgewiesen,

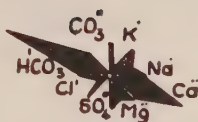
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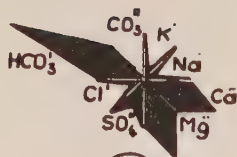
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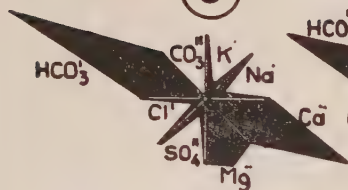
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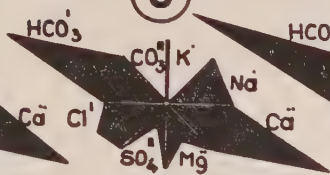
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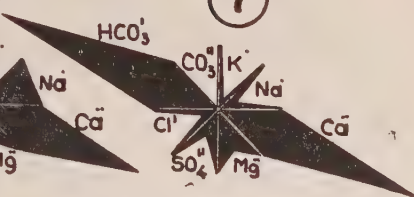
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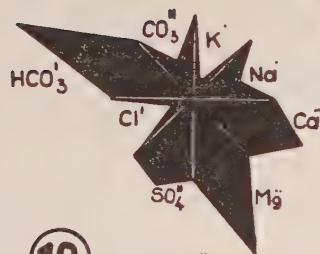
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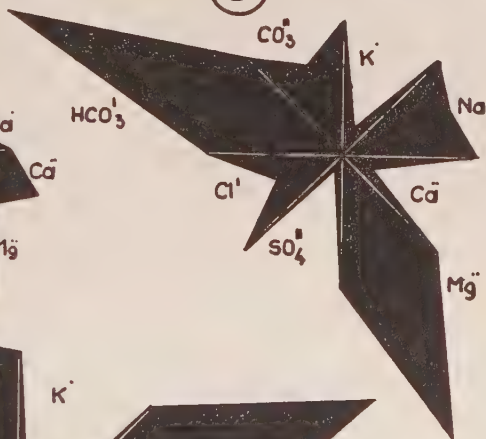
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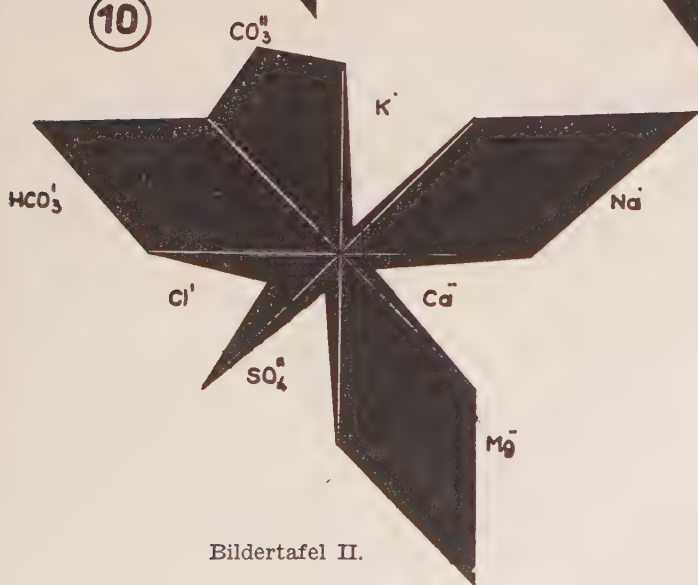
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Bildertafel II.

dass die Feststellung des Trophigrades von Gewässern einwandfrei nur durch die Konzentrationsverhältnisse des gelösten Sauerstoffs bzw. des ausnutzbaren CO₂ Gehaltes festgestellt werden kann, da diese die Zustandsanzeiger des rück-

Benennung der Gewässer.	Hälfte der Bikarbonat- Kohlensäure CO ₂ mg/l	Zugehörige freie Kohlensäure CO ₂ mg/l	Summe von Ausnutzbare Kohlensäure CO ₂ mg/l 1.u.2	R ²	Trophie- grad.
	1.	2.	3.	4.	5.
Gewässer der β -limno Type.					
Mohos láp	1,96	0,00	1,96	0,03	dystroph
Kleiner Uklei	2,64	0,00	2,64	0,04	"
Szent Anna tó	3,92	0,00	3,92	0,06	oligotroph
Baikalsee	12,3	0,2	12,5	0,18	"
Genfer See	12,3	0,2	12,5	0,18	"
Davoser See	21,1	0,5	21,6	0,32	"
Lake Superior	22,7	0,6	23,3	0,34	"
Aral See *	32,4	1,2	32,6	0,50	"
Kaschpi See **	35,2	1,4	36,6	0,54	"
Lake Huron	37,8	1,6	39,4	0,58	"
Szamos Fluss	42,0	2,0	44,0	0,65	"
Lake Erie	43,5	2,2	45,7	0,68	"
Lake Michigan	45,0	2,4	47,4	0,70	"
Alter Donau Arm zu Lágymányos					
bei Budapest	50,6	3,1	53,7	0,79	"
Bodensee	50,8	3,1	53,9	0,79	"
Lunzer Untersee	51,1	3,2	54,3	0,81	eutroph
Grosser Plönersee	51,2	3,2	54,4	0,81	"
Zürichsee	55,1	3,9	59,0	0,87	"
Duna Fluss	57,0	4,3	61,3	0,91	"
Tisza Fluss	57,2	4,3	61,5	0,91	"
Adria ***	60,1	4,8	64,9	0,98	"
Gyilkos tó	67,8	6,8	74,6	1,11	"
Öreg tó zu Tata	103,4	25,3	128,7	1,91	"
Gewässer der α -limo Type.					
Balatonsee	84,4	—	—	1,25	eutroph
Tanganjikasee	89,9	—	—	1,33	"
Sóstó zu Székes- fehérvár	140,1	—	—	2,07	"
Palicser See	211,6	—	—	3,14	stark eutr.
Belső tó zu Tihany	216,7	—	—	3,21	"
Szelider See	259,2	—	—	3,85	"
Harkasee	332,4	—	—	4,93	"
Fertősee	377,3	—	—	5,59	"
Velenceesee	452,1	—	—	6,71	"

× Limnohalin Typus ×× Limnohalin Typus ××× Halin Typus

läufigen Redoxkreisprozesses *Aufbau*·*Abbau* sind. Der Konzentration der Stickstoffverbindungen und den als Ernährung dienenden anderen Pflanzennährstoffen, seien diese von ökologischer Seite noch so wichtig, kann in dieser Hinsicht kein entscheidender Einfluss zugeschrieben werden, da diese Nährstoffe bei der *Spaltung des Kohlendioxyds keine Rolle spielen* und deswegen zur Vergrößerung des ursprünglichen potenziellen Energievorrates des Holocönoids nichts beitragen. Diese Tatsache lässt sich aus dem Gesetz der *freien Energie* folgern, wonach die Änderung des freien Energiegehaltes eines Systems während des rückläufig vor sich gehenden Kreisprozesses nur von dem *Anfangs-* und *Endzustande* bedingt wird, von dem *Wege* aber an dem sich der Umsatz vollzieht, gänzlich *unabhängig* ist. Dass in dem limnischen Holocönoid auch Proteine auf- und abgebaut werden hat mit dem autotroph erworbenem freien Energievorrat des Systems nichts zu tun, da in dem Anfangszustande durch Photosynthese noch keine Proteine gebildet werden.

Für den Sauerstoffgehalt — als Anzeiger des Endzustandes — hat THIENEMANN in seiner Seetypenlehre in dieser Hinsicht den Beweis erbracht. Für den ausnutzbaren CO₂ Gehalt des Wassers, als Anzeiger des Ausgangszustandes, versuchten wir in dieser Arbeit dasselbe zu tun. Dies geschah mittelst einer graphischen Darstellungsmethode der chemischen Zusammensetzung des Wassers nach dem Verfahren des Verfassers. Auf diesem Wege gelang es, einen Nachweis zu schaffen, wonach die Produktionsfähigkeit der Gewässer Pflanzennährstoffen aus dem ausnutzbaren CO₂ Gehalt an ebenso gut feststellbar ist, wie durch deren Sauerstoffschichtung.

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1. *Harkasee*. Ein Sodasee in *Südungarn*. (Analyse d. Verfassers. 1945.)
2. *Belső tó* zu *Tihany*. Ein Weicher. (Analyse d. Verfassers. 1945.)
3. *Velenceesee*. Ein etwa 2000 Ha. grosser flacher See in *Transdanubien*. (Analyse d. Verfassers. 1945.)
4. *Fertősee*. Ein flacher See in *Westungarn*. (Analyse d. Verfassers. 1945.)
5. *Szelider See*. Ein einstiger *Donauarm* in *Transdanubien*, welcher angeblich von Bodenquellen gespeist wird. (Analyse d. Verfassers. 1945.)
6. *Schärentümpel* in *Suomi*. Von *Järnefelt* mit der Zahl 13. bezeichnet. (Analyse von *Järnefelt* 1939.)
7. *Meerwasser* aus dem *Schärentümpel* 12. nach *Järnefelt*. (Analyse von *Järnefelt*. 1939.)

8. *Schwarzes Meer*. Wasserprobe aus *Varna, Bulgarien*. (Analyse d. Verfassers. 1945.)
9. *Adria*. (Analyse d. Verfassers. 1932.)
10. *Sickerwasser* aus der *Tropfsteingrotte zu Aggtelek, Nordungarn*. *Királykut*. (Königsbrunne) (Analyse d. Verfassers. 1945.)
11. *Öregtő* zu *Tata, Transdanubien*. (Analyse d. Verfassers. 1945.)
12. *Wasseransammlung* in der Nähe der *Puszta Hortobágy, Darvasalom* bei *Kunmadaras*. (Analyse d. Verfassers. 1945.)
13. *Mohos láp*, ein dystrophes Moor in *Ostungarn*. (Analyse d. Verfassers. 1945.)
14. *Igmándor Bitterwasser-Quelle*. (Analyse von *I. Telkessy*.)
15. *Alter Donau-Arm* zu *Lágymájos-Budapest*. (Analyse d. Verfassers. 1945.)
16. *Kaschpisee*. (Nach den Angaben von *W. Halbfass*. 1923.)
17. *Schärentümpel* in *Suomi*. Von *Järnefelt* mit der Zahl 14. bezeichnet. (Analyse von *Järnefelt*. 1939.)
18. *Ozeanisches Wasser*. Mittelwert von mehr als 100 Analysen. (*Forchhammer*. 1855., *Dittmar*, 1876 und *Natterer*.)

ERKLÄRUNGEN ZUR TAFEL 2

1. *Mohos láp*. Wie in *Tafel 1. No. 3. Dystroph*.
2. *Szent Anna tó*. Ein Kratersee (Maar) in *Ostungarn*. Oligotroph. (Analyse von *E. Woynarovich*, noch nicht publiziert.)
3. *Genfer See*. (Nach den Angaben von *W. Halbfass*, 1923.) Oligotroph.
4. *Davoser See*. (Analyse von *Bourcart*. Nach *Schmassmann* 1924.) Oligotroph.
5. *Lake Huron*. (Nach den Angaben von *Halbfass* 1923.) Oligotroph.
6. *Grosser Plöner See*. (Analyse von *W. Ohle*. 1938.) Schwach eutroph.
7. *Zürichsee*. (Analyse von *L. Minder* 1943.) Schwach eutroph.
8. *Balatonsee*. (Analyse von *A. Lindmeyer*, *Maucha* 1932.) Eutroph.
9. *Belső tó* zu *Tihany*. (Analyse d. Verfassers.) Stark eutroph.
10. *Velenceesee*. (Analyse von *A. Lindmeyer*. s. *Maucha* 1945.) Stark eutroph.

On the Ecology of some small Lakes near Buitenzorg, Java

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In the vicinity of Buitenzorg, Java, a great number of small lakes are found, locally known as "situs" of which some are situated along the mainroad from Buitenzorg to Batavia. Barring the very small ones, we can count about eighty with an average surface of 1 to 3 ha. and a few larger ones of 20-30 ha. The usual depth is 3 m. at most, some of the larger ones attain a depth of 10 m. These situs are situated in shallow basins and can be regarded as natural or artificial stowage basins.

All of them are situated on old andesitic-lateritic soil, extremely poor in soluble plant food, with a high contents of iron and a striking deficiency of Potassium, Calcium and Phosphorus. Those mineral substances that are present in the soil, seem to occur in such a form, as to be hardly available to the vegetation and as a result these soils are very poor. The situs, being filled with rain and water draining a poor area are bound to show an oligotrophic environment, as was born out by our investigations.

A division suggests itself into two groups, 1) those without any inflow of draining water and totally dependent on rain and 2) those that show one or more inflowing streamlets. The latter type may be divided into those draining the numerous rubber estates of the Buitenzorg area, and those draining paddy fields and villages. As the yearly crop of fallen *Hevea* leaves does not increase fertility to a great extent, an increasing trophic condition in the above mentioned groups in the order 1-2-3 is to be seen.

The usual pH of the water is about 6,8, in the sun, the lowest value found so far being 5,2 in the morning in the situ Tjibuntu, and the maximal one a pH of 7,5 at noon in the situ Tjibinong near the outflow. The inflowing water of the same lake showed a pH of 6,7 at the same time, so we see that photosynthesis, operating at its highest rate, was not able to shift the reaction to the alkaline side.

Methylorange-alkalinity (the german „Säurebindungsvermögen"), a measure for the amount of bicarbonates and conse-

quently also for the Calcium content (provided the amount of other alcalemic ions as Mg. etc. is negligible) proved to be very low indeed, never exceeding 0,5 with an average of 0,33 and a minimum of 0,12. This means, that taking the above mentioned assumption for granted, which is a safe one in the above case, a Calcium content of 8,4 average and 3,4 and 14 mgr./l. as extreme values.

An excess of free carbondioxyde can always be found. From various observations we could calculate an average of 8 mgr./l. with 2 and 35 mgr./l. as extreme values. The amount of Carbondioxyde, in equilibrium with the calcium found, would have been of the order of 0,1 mgr./l. The excess is the cause of the feeble acid reaction of the various situs.

The amount of phosphate ranged from 0,006–0,077 mgr./l. and nitrate was found at an average amount of 0,3 mgr./l. N_2O . Organic substances dissolved in the water were determined with the permanganate method and proved to be low.

These oligotrophic lakes showed a scanty vegetation as was to be expected. Of the usual submerged vegetation, often showing such a luxurious development in tropical lakes, only a few *Najas*, *Hydrilla verticillata* and *Ceratophyllum* were found. The more acid the water, the poorer the vegetation. *Utricularia*, in various species, is often met with, the carnivorous habits of this plant will be a big asset in these poor waters.

Of the floating vegetation *Limnanthemum indicum* and *Nelumbium*, may be found and often, too often, *Eichhornia crassipes* occur. As in every part of Java, the latter plant, introduced in 1894 from Brazil, threatens to choke all surface water and drive away all other vegetation.

Separate from our general survey¹⁾, we have been able to study two of these lakes more in detail, e.g. the Situ Mangga Bolong located on the grounds of the lunatic asylum at Len-tenagung and a small lake on the grounds of the Sawangan rubber estate²⁾, in the following lines to be referred to as "Situ Sawangan". It proved to be of interest to compare these two with a third lake the "Telaga Warna".

The latter is a lake of a very different type and situated in altogether different surroundings. It is a crater-lake on the N.W. slope of the Gedeh-Pangerango volcano complex, at a height of 1350 m, about 35 km. from Buitenzorg. The Telaga Warna is a small lake with a diameter of about 70 m. and a depth of 7 m. The walls are rather steep and the lake has neither inlet nor outlet, so it is an example of a lake of the first type described above.

1) A great deal of the above mentioned data were extracted from a report of B. M. Hoeks, formerly of the Laboratory of Freshwaterfisheries.

2) In this estate three small lakes are found, locally known as Situ Pasir Putih, Situ Gede and Situ Pangasinan, the following data pertain to the first mentioned lake.

Only, as will be stated further down, it is not directly comparable with the lakes in the lowlands, because the soil is less decayed and more mineral substances are available. As a result of the greater humidity of the air, of the much lower temperature at these higher altitudes and of the shade provided by the trees which closely surround the lake, evaporation will not be great. The lake is almost completely rain-fed but in this case the rain water will be penetrating a soil which is not so poor as in the plains. The lake has no contact with villages being entirely surrounded by tea estates and secondary forests. It is obvious that oligotrophic conditions will prevail in this case too but not so pronounced as in the two previous ones. The Telaga Warna has hardly any submerged vegetation but for some small patches or grasses, it has hardly any shore development at all. Lack of accommodation was the reason we did not study the bottom deposits. The lake situated within the rubber estate Sawangan had a round surface of about 30 ha. and a maximum depth of 10 m., and also rather steep shores with poorly developed shore vegetation.

It receives, however, drainage water from the surrounding rubber vegetation and during the wet monsoon there is a very small increase in surface. The inundation of shores is however too slight to play an important part in the ecology of the lake. The bottom deposits consisted of slowly decaying vegetation mostly rubber leaves, with hardly any organisms living on it. The situ Mangga Bolong has a more elongated form with a length of 825 m. and a width of 250 m., its total surface being about 18 ha. The latter is much shallower than the two other ones, having an average depth of 1 m. with about 2 m. maximum. The western shore is rather steep but the eastern one is very shallow, sloping down gradually. During the high water period, the inundated shores in the western part can reach a width of 5-10 m. These grounds show a poorly developed vegetation of grasses. Submerged vegetation was absent barring some *Nitella* along the western shore. In the Northern part a floating vegetation of *Limnanthemum indicum* was seen with, further along the shore, some grasses and Cyperaceae.

In table 1 we summarize the results of some chemical estimations. In the case of the Telaga Warna we had no canoe at our disposal, so we were not able to study other than surface samples. The determination of P, N and NH_4 was carried out on well preserved samples by B. Markus, Chemist at the Laboratory of Freshwater Fisheries.

Table 1

Object	Situ Mangga Bolong					Situ Sewangan		Telaga Warna
	open water surface	open water 200 cms.	W. side surface	N. side surface	open water surface	open water 200 cms.	open water surface	
Location of Sample	8h.40	8h.40	9h.45	10h.30	10h.	10h.30	open water surface	open water surface
Depth of sample	7,0	6,8	6,8	6,7	6,5	6,2	9h.30	9h.30
Time	25,1				24,1		7,8	7,8
pH.	0,25	0,25	0,35	0,25	0,5	0,4	21,5	21,5
Temperature ° C.	7	7	10	7	14	11	1,25	1,25
Alcalinity	3,8	3,5	3,6	3,5			38	38
CaO mgr./l.	0,006							
O ₂ mgr./l.	0,3							0,8
P ₂ O ₅ mgr./l.	0,0							0,0
N ₂ O ₅ mgr./l.	14							37
NH ₄ mgr./l.	70	23 (bottom)	70 (bottom)			80	water clear	water clear
K Mn O ₄ mgr./l.							do	do
Secchi disc in cms.	bright sunshine							
Weather								

On the strength of these data, we feel confident to call all three objects oligotrophic lakes, Telaga Warna slightly so, but the two other offer extreme cases of oligotrophy caused by very low Calcium, Phosphor and Nitrogen contents. The differences between the shallow situ Mangga Bolong, surrounded by paddy fields and gardens and the much deeper situ Sawangan surrounded by shady trees, is strikingly expressed by the difference in pH and Ca. Although the latter lake has the higher Ca contents the acidity of the water is higher too. In this case there is more free CO₂ and photosynthesis plays a less important part. We shall see that plankton investigations confirm this statement. In Telaga Warna the greater depth and unfavourable shore development are compensated by the greater amount of available mineral substances. In this case photosynthesis plays a more prominent role, as seen by the higher pH and consequently lower CO₂ content as well as by the different microflora.

Plankton studies were carried out on preserved net samples by a slightly modified Sedgewick-Rafter method. The total amount of water strained was 18 l. In the quantitative samples we counted the net plankton only, in the case of the Mangga Bolong we took the average of 4 samples, in the other lakes of 2. On the qualitative samples we added the results of a study of periphytic and bottom dwelling algae.

Table 2 gives an idea of the relative importance of the principal genera and table 3 gives a qualitative survey. In the latter table we added the results of the German Sunda Expedition (various authors in Archiv für Hydrobiologie, Supplem. 8-16, Tropische Binnengewässer), and the data of Steinmann (1935).

If we study these data the following remarks can be made:

- 1) In the Situ Mangga Bolong, with its extreme low Calcium contents, an enormous outburst of Desmids is found, 65% of all microorganisms being *Staurastrums*, while no less than 30 different species were seen. Diatoms and Blue-green algae were almost entirely absent.
- 2) In the Situ Sawangan, with its slightly higher Calcium contents, but less favourable morphometric conditions, (greater depths and steeper shore together with less favourable surroundings viz. rubber trees instead of paddy fields and gardens), more Diatoms and less Desmids are found, from the latter group a preponderance of *Cosmarium* species is striking. Zooplankton plays a much greater part in this case.
- 3) The Telaga Warna gives an example of an oligotrophic environment with more Calcium, inhabited by Chlorophyceae (*Ceratium hirudinella*, *Peridinium gutwinskii*) and *Botryococcus braunii*, together with a fair amount of Zooplankton and many Diatoms.

Steinmann (l.c.) was able to compare samples taken in the dry season with those from the wet season and found a

Table 2

Principal genera of 3 small javanese lakes.

ORGANISMS	OBJECTS.			SYSTEMATICAL GROUP
	MANGGA BOLONG	SITU SAWA-GAN	TELAGA WARNA	
<i>Microcystis</i>	170			Cyanophyceae.
<i>Scenedesmus</i>	510	510	170	
<i>Scenedesmus</i>		1929		
<i>Navicula</i>	2210			Diatomeae.
<i>Navicula</i>		3570		
<i>Navicula</i>		170	100	
<i>Desmidiaceae</i>	510			Desmidiaceae.
<i>Desmidiaceae</i>	170			
<i>Desmidiaceae</i>	14475	170		
<i>Desmidiaceae</i>	1470			
<i>Desmidiaceae</i>	170			
<i>Desmidiaceae</i>	170			
<i>Desmidiaceae</i>	510			
<i>Desmidiaceae</i>	2323			
<i>Desmidiaceae</i>	170			
<i>Desmidiaceae</i>		170		
<i>Zygnemataceae</i>	340			Zygnemataceae.
<i>Heterochloridales</i>	340		9100	Heterochloridales.
<i>Peridinium</i>		170	100	Peridineae.
<i>Peridinium</i>	510		1360	
<i>Protozoa</i>	170			Protozoa.
<i>Protozoa</i>	340		100	
<i>Chrysomonadales</i>	340			Chrysomonadales.
<i>Rotifera</i>	170			Rotifera.
<i>Rotifera</i>	170		100	
<i>Rotifera</i>	340			
<i>Crustacea</i>		2890	800	Crustacea.

marked periodicity of the plankton. *Botryococcus* proved to be more abundant during the wet season while *Ceratium* and *Peridinium* were more abundant during the dry season. The reason for this phenomenon is still to be found, because the influence of the change in monsoon will not be very strongly felt in a small lake like this, without in- or outlet. As van Oye (1929) pointed out, rain is the primary cause of periodicity in tropical waters, differences of temperature being insufficient to effect drastic changes. Still it remains to be seen whether this is also the cause in small lakes like this, where the influence of rain is bound to be slight.

- 4) Blue-green algae did not play an important part in either of the three objects, as was to be expected from their mineral contents.

We can make the following notes concerning the different species seen.

- 1) *Micrasterias mahabuleshwariensis* Hobs v. *surculifera* Lagerh. Our form corresponds exactly with the one described by Lagerheim from Bengal and does not show the deviations Krieger described in his material from the German Sunda Exp.
- 2) *Pleuroteanium kayei* Rab.
Our form has two rows of single and 4 rows of double spines on each hemicell while, in Krieger's descriptions 5 double and 1 single row of spines are always mentioned.
- 3) *Botryococcus braunii* Kütz. We found large colonies, full of fat floating on the surface.

Table 3. Microflora and fauna of three Javanese lakes.

(In the case of Telaga Warna *E* means seen by the German Sunda Expedition, *S* means seen by Steinmann and *VS* means our own observations.)

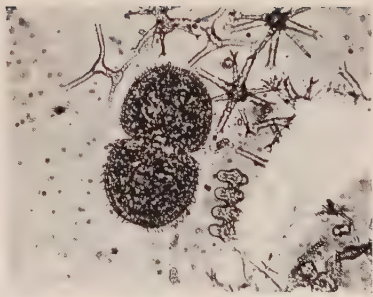
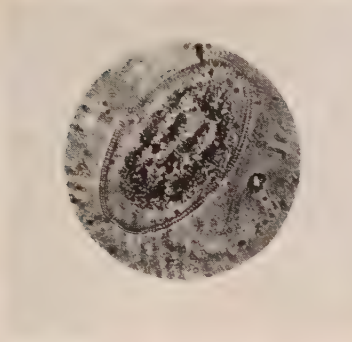
Table 3

	SITU M.B.	SITU SAWA- GAN	TELAGA WARNA	SYSTEMATICAL GROUP
<i>Chroococcus indicus</i> B.	x			Cyanophyceace
<i>Microcystis minimus</i> B.	x			
<i>Actylococcopsis falcicularis</i> Lemm.	x	x		
<i>Scirulina major</i> Kütz	x	x	VSS	
<i>Synechocystis rigidula</i> Geitl			E	
<i>Chormidium</i> spec.			E	
<i>Scenedesmus spec.</i>			E	
<i>Nostoc carneum</i> Ag.			S	
<i>Scillatoria</i> spec.	x	x	S	
<i>Avicula</i> spec.	x	x	VSES	Diatoms
<i>Avicula cryptocephala</i> Kütz			E	
<i>Avicula lagerheimi</i> Cl.			E	
<i>Avicula radiosa</i> Kütz	x	x	VSES	
<i>Leptocylindrus spec.</i>		x		
<i>Leptocylindrus amphibia</i> Grun.			E	
<i>Leptocylindrus ruttneri</i> Hust.			E	
<i>Leptocylindrus spec.</i>		x		
<i>Leptocylindrus spec.</i>			VSE	
<i>Leptocylindrus exigua</i> v. <i>heterovalvata</i> Krasske			E	
<i>Leptocylindrus lanceolata</i> (Breb) Grun.			E	
<i>Leptocylindrus lanceolata</i> v. <i>rostrata</i> (Ost) Hust.			E	
<i>Leptocylindrus microcephala</i> (Kütz) Grun.			E	
<i>Leptocylindrus minutissima</i> Kütz			E	
<i>Leptocylindrus minutissima</i> V. <i>Cryptocephala</i> Grun.			E	
<i>Leptocylindrus tenuissima</i> Hust.			E	
<i>Leptocylindrus hustedti</i> Krasske				
<i>Leptocylindrus placentula</i> Ehr			E	
<i>Leptocylindrus kuetzingiana</i> Thw.			S	
<i>Leptocylindrus spec.</i>		x		
<i>Leptocylindrus alpinoides</i> Hust.			E	
<i>Leptocylindrus mulleri</i> v. <i>javanica</i> Hust.			E	
<i>Leptocylindrus turgida</i> (Greg) Cl.				
<i>Leptocylindrus pelagica</i> Hust.			E	
<i>Leptocylindrus vanhureki</i> Brun.			E	
<i>Leptocylindrus subovalis</i> Cl.			E	
<i>Leptocylindrus sores</i> Kütz			E	
<i>Leptocylindrus dissimilia</i> Hust.			E	
<i>Leptocylindrus flexuosa</i> (Breb) Kütz			E	
<i>Leptocylindrus tschirchiana</i> O.M.			E	
<i>Leptocylindrus rhomboides</i> v. <i>saxonia</i> (Rubh) Dt.			E	
<i>Leptocylindrus vulgaris</i> v. <i>elliptica</i> Hust.			E	
<i>Leptocylindrus omphonomema</i> Clevei Fr.			VSE	

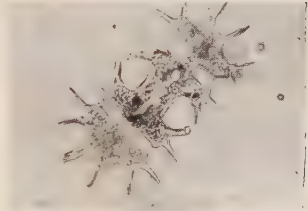
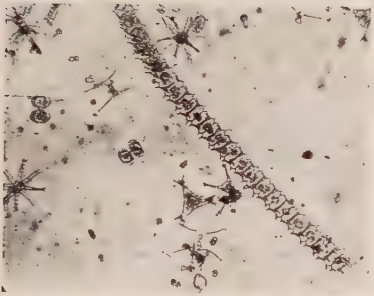
	SITU M.B.	SITU SAWA- GAN	TELAGA WARNA	SYSTEMATIC GROUP
<i>Gomphonema gracile</i> Ehr			VSE	
<i>Gomphonema intricatum</i> v. <i>dichotoma</i> (Kütz) Grun			E	
<i>Gomphonema intricatum</i> v. <i>pumila</i> Grun			E	
<i>Gomphonema lanceolatum</i> Ehr			E	
<i>Gomphonema parvulum</i> (Kütz) Gr.			E	
<i>Melosira granulata</i> f. <i>curvata</i> Grun			VSE	
<i>Melosira gran.</i> f. v. <i>angustissima</i> O.M.			VSE	
<i>Navicula contenta</i> v. <i>biceps</i> Arn.			E	
<i>Melosira roeseana</i> Rabh			E	
<i>Pinnularia interrupta</i> W. SM.			E	
<i>Pinnularia graciloides</i> Hust.				
<i>Pinnularia leptocoma</i> Grun			E	
<i>Pinnularia virides</i> (Nitzsch) Ehr.			E	
<i>Rhopalodia spec.</i>		X		
<i>Rhopalodia gebba</i> (Eh) CM.			E	
<i>Stephanodiscus astraea</i> (Ehr) Grun.			E	
<i>Surirella fonticola</i> Hust.			E	
<i>Surirella ovalis</i> Breb.		X	S	
<i>Surirella javanica</i> Breb.			S	
<i>Synedra rumpens</i> v. <i>neogena</i> Grun			E	
<i>Synedra rumpens</i> v. <i>scotia</i> Grun			E	
<i>Synedra ulna</i> (Nitzsch) Ehr			E	
<i>Synedra acus</i> Kütz		X		
<i>Gonatozygon pilosum</i> W.	X	X		
<i>Closterium kützingii</i> Breb.	X	X		
<i>Pleurotaenium ehrenbergii</i> de B.	X	X		
<i>Pleurotaenium wallichianum</i> (Turn)		X		
<i>Pleurotaenium kayei</i> Rab.		X		
<i>Triploceras gracile</i> Bail	X			
<i>Pleuroteaniopsis suburgida</i> Sch. fa. minor Schm.	X			
<i>Cosmarium contractum</i> Kirchn.			VSE	
<i>Cosm. moniliforme</i> (Turp) Ralfs	X	X		
<i>Cosm. margaritatum</i> (Lund.) Roy et Bils	X	X		
<i>Cosm. obsoletum</i> (Hantz)				
<i>Reinsch. var. sitvense</i> Gutw.	X			
<i>Cosm. turpinii</i> Breb. var. <i>intermedium</i> Krieger	X			
<i>Xanthidium antilopaeum</i> K. f. <i>javanica</i> Nordsd	X			
<i>Xanth. subtrilobum</i> W et W	X			
<i>Xanth. freemanni</i> W. var. <i>spinosissimum</i> Bern	X			

	SITU M.B.	SITU SAWA- GAN	TELAGA WARNA	SYSTEMATICAL GROUP
<i>urastrum formosum</i> B.		x		Desmids.
<i>leptacanthum</i> N.		x		
<i>wildemanni</i> G.		x		
<i>gutwinskii</i> B.		x		
<i>longibranchiatum</i> (Borge) Gutw.		x		
<i>linneticum</i> Sch.		x		
<i>sonthalianum</i> Turner		x		
<i>sexanfulare</i> var. <i>bidentatum</i> G. .		x		
<i>spiniceps</i> Krieger		x		
<i>megacanthum</i> L.		x		
<i>zahlbruckneri</i> L.		x		
<i>subtrifurcatum</i> W. var. <i>major</i> W.				
et W.		x		
<i>setigerum</i> Cl. var. <i>tristichum</i> N. .		x		
<i>astrum spinulosum</i> D. var. <i>inernius</i> Nordst.		x		
<i>crasterias alata</i> Wall	x	x		
<i>cr. foliacea</i> B.	x	x		
<i>cr. mahabuleswarensis</i>		x		
<i>v. surculifera</i> L.				
<i>cr. radiata</i> H. v. <i>bogoriensis</i> (B.) .		x		
<i>ondylosum nitens</i> A. v. <i>triangulare</i> T.		x		
<i>on. tetraganum</i> W.		x		
<i>ychonema leave</i> N.		x		
<i>haerzosma</i> spec.	x	x		
<i>smidium</i> spec.	x	x		
<i>valotheca dissiliens</i> var. <i>hians</i> W. .	x	x		
<i>irogyra</i> spec.	x	x		Zygnemataceae.
<i>ugeotea</i> spec.	x	x		
<i>gnema</i> spec.	x	x		
<i>doginium</i> spec.			VS	Oedogoniaceae.
<i>ridinium javanicum</i> B.	x			Peridinaeae.
<i>r. gutwinskii</i> Wol.			S ES	
<i>r. inconspicuum</i> var. <i>armatum</i> . .				
<i>lenm.</i>				
<i>midinium</i> spec.			VS	
<i>ratium hirudinella</i> O F M	x	x	VSES	
<i>tryococcus braunii</i> Kütz			VS S	Heterochloridales

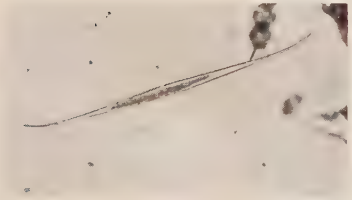
	SITU M. B.	SITU SAWA- GAN	TELAGA WARNA	SYSTEMATIC GROUP
<i>Pediastrum duplex</i> M.	x			Chlorococcales.
<i>Ped. ehrenbergii</i> A. Br.		x		
<i>Scenedesmus quadricaudata</i> Breb.				
<i>Eudorina spec.</i>		x		Volvocales.
<i>Malomonas javanica</i> St.			S	
<i>Trachelomonas armata</i> var.				Euglenaceae.
<i>Stenii</i> Lenm.			VS S	
<i>Euglena acus</i> Ehr	x			
<i>Dinobryon sertularia</i> Ehr	x	x	S	Chrysomonadales.
<i>Arcella vulgaris</i> Ehr	x	x	VS	Protozoa.
<i>Diffugia spec.</i>	x	x	VS	
<i>Vorticella spec.</i>			VS	
<i>Keratella valga</i> f. <i>asymmetrica</i> (Apst)	x		VS E	Rotifera.
<i>Brachionus angularis</i> G.	x		VS E	
<i>Brach. calyciflorus</i> Pallas			VS E	
<i>Pedalion spec.</i>	x			
<i>Diurella spec.</i>	x	x		
<i>Filinia spec.</i>		x		
<i>Anuraeopsis navicula</i> Rous			E	
<i>Pompholyx sulcata</i> Huds			E	
<i>Monostyla homata</i> Stokes			VS	
<i>Polyarthra spec.</i>	x	x		
<i>Ectocyclops spec.</i>			VS	Crustaceae.
<i>Mesocyclops dissipiens</i> Kiefer			E	
<i>Mesocyclops leuckarti</i> Claus			E	
<i>Diaphanosoma spec.</i>	x			
<i>Bosmina spec.</i>		x		
<i>Ostracode</i>		x		
<i>Nematode</i>		x		Worms.



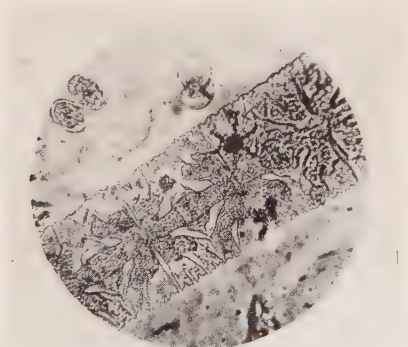
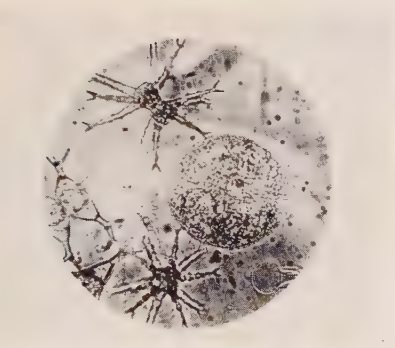
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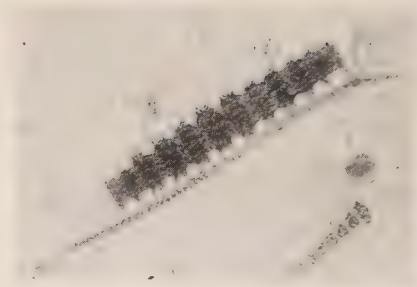
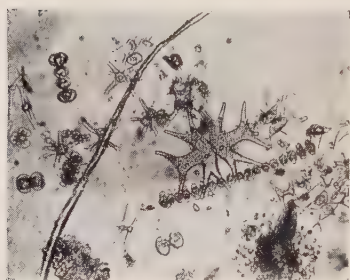


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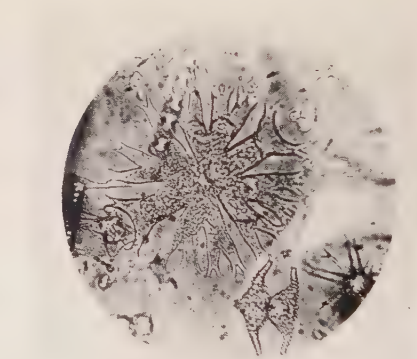
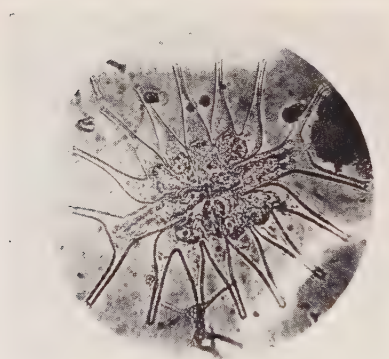


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List of photoprints.

- 1) *Pleurotaeniopsis suburgida* (T) Schm. fa *minor* Schm. $\times 500$, true length $100\ \mu$ from S.M.B. photo Sachlan.
- 2) *Onychonema laeve* Nordst $\times 330$, actual width $19\ \mu$ from S.M.B. photo Sachlan.
- 3) *Closterium kuetzingii* Breb. $\times 160$ actual length $400\ \mu$ from photo Sachlan.
- 4) *Cosmarium obsoletum* (H) R. var. *sitvense* Gutw. $\times 500$. actual width $47\ \mu$ from S.M.B. photo Sachlan.
- 5) *Xanthidium freemani* W. var. *spinosissimum* Bern $\times 900$ actual length $85\ \mu$ photo Sachlan.
- 6) *Xanthidium subtrilobum* W. et W. $\times 450$, actual length with spines $70\ \mu$ from S.M.B. photo Sachlan.
- 7) *Ceratium hirudinella* O.F.M. $\times 400$. actual length $130\ \mu$ from Saw. photo Vaas.
- 8) *Micrasterias foliaceae* Bail $\times 440$. actual length $70\ \mu$ from Saw. photo Vaas.
- 9) *Micrasterias mahabuleswarensis* Hobs. v. *surculifera* Lagerh. $\times 330$. actual length $160\ \mu$ from S.M.B. photo Sachlan.
Out of focus *Sphaerosoma* spec.
- 10) *Micrasterias alata* Wall $\times 330$, actual length without spines $150\ \mu$ from S.M.B. photo Vaas.
- 11) *Pleurotaenium kayei* Rab. $\times 250$. actual length $360\ \mu$ from S.M.B. photo Sachlan.
- 12) *Micrasterias radiata* Hars. Var. *bogoriensis* (Bern) $\times 350$. actual length $160\ \mu$ from S.M.B. photo Sachlan.
- 13) *Staurostrum wildemani* Gutw. $\times 600$. actual width with spines $125\ \mu$ from S.M.B. photo Sachlan.

Zusammenfassung.

In der Umgebung von Buitenzorg auf Java liegen ungefähr 80 Stauseen, deren Grösse, bei einer Tiefe von annähernd 3 Metern, zwischen 1 und 3 ha schwankt. Sie haben einen eisenreichen Boden aus andesitisch-lateritischem Material, dessen Nährstoffe den Pflanzen schwer zugänglich sind. Die Wasserversorgung der Seen besteht aus Regenwasser und dem Zufluss aus den armen Hügelland der Umgebung.

Die Untersuchung des Seewassers ergab einen durchschnittlichen pH-Wert von 6.8 mit Schwankungen zwischen 5.2 und 7.2. Die Reaktion wurde selbst während der Tagesstunden durch die

Photosynthese kaum alkalisch. Das Säurebindungsvermögen betrug durchschnittlich 0.33 bei einem Minimum von 0.12. In allen Fällen wurde ein Ueberschuss an freier Kohlensäure gefunden, der zwischen 2 und 35 mgr im Liter wechselte und als Verursacher der sauren Reaktion anzusehen ist. Der Phosphatgehalt schwankte zwischen 0.006 und 0.77 mgr im Liter, während bei einem fast vollständigem Fehlen von aufgelöster organischer Substanz ein Nitratgehalt von durchschnittlich 0.3 mgr/L festgestellt wurde.

Die Unterwasser-Flora bestand aus einem spärlichen Wuchs von *Najas*, *Hydrilla verticillata*, *Ceratophyllum* und *Utricularia*. Auf der Wasseroberfläche kamen *Limnanthemum indicum*, *Nelumbium* und *Eichhornia crassipes* vor.

Zwei dieser Seen, der Situ Mangga Bolong und der Situ Sawangan wurden eingehend untersucht und mit den 35 km von Buitenzorg entfernt gelegenen Kratersee Telaga Warna, dessen Durchmesser 70 m und Tiefe 7 m beträgt, verglichen. Bezüglich der Ergebnisse der chemischen Wasseranalyse wird nach Tabelle 1 im Text verwiesen. Der Oligotrophismus der Seen wird deutlich demonstriert.

Die Untersuchung des Planktons erfolgte nach der Sedgewick Methode. Die Ergebnisse sind zu finden in Tabelle 2 im Text. Sie lassen die folgenden Schlüsse zu:

1. In dem sehr kalkarmen Situ Mangga Bolong kommt es zu einer wahren Desmidiaceen-blüte. 65% der Mikroorganismen besteht aus *Stauroastrum*spezies.

2. In dem etwas kalkarmen Situ Sawangan mit seinen günstigeren morphometrischen Verhältnissen, kommen mehr Diatomeen und weniger Desmidiaceen vor, während auch Zoöplankton auftritt.

3. Der Telaga Warna ist ein oligotrophischer See mit einem grösseren Kalkvorrat in dem Grünalgen in Gemeinschaft mit Diatomeen und Zoöplankton vorkommen.

In der im Text aufgenommenen Tabelle 3 sind alle in den drei Seen festgestellten Organismen aufgenommen, wobei die in den selben Seen gemachten Funde der deutschen Sunda-expedition und die A. Steinmanns verwertet wurden.

Ecological Studies of Some Marine Algae from Alexandria

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I. Introduction

Our knowledge of the Egyptian Mediterranean in general, is still meagre, due to the little effort devoted in collecting and identifying algae, particularly during the short visits paid by some algologists to our shores. The present work is an attempt of a prolonged study of the marine algae at Alexandria district from September 1943 till June 1945; a study based on ecological observations on the marine algae inhabiting the shores of Alexandria and its vicinities. It contains the results of regular visits to the different localities throughout that period.

The effect of the chemical and physical factors on the vegetation was undertaken with special mention of the effect of salinity on the profusion and distribution of the algae. Determinations of the nutritive salts were made throughout a whole year. The results obtained have thrown some light on the plankton cycle described by other workers. A study of epiphytism based on field observations is also given.

The present work embodies also the algal vegetation mainly occurring in the littoral belt. In few occasions the vegetation of the sublittoral belt is investigated.

II. The Area

The area investigated extends over 40 kilometers along the Egyptian Mediterranean shores between El Ma'adya, on Abu Qir Bay, and Mex; two places lying to the east and west of Alexandria respectively.

The area offers considerable variety of algal habitats due to the presence of both sheltered and exposed situations, streaming of fresh water from the Nile and brackish water from the lakes, and lastly the presence of different substrata with varying degrees of suitability for algal growth.

The following table indicates the stations so far investigated, together with the prevailing water conditions at each station.

Table I

St. Number	Name	Character
1	El Ma'adya	sheltered.
2	Abu Qir	sheltered near the Bay, otherwise exposed.
3	Mandara	Exposed at Asafra.
4	Sidi Bishr	Bir Masoud very exposed; otherwise exposed.
5	Glymonopolo	Exposed.
6	Stanley Bay	Eastern side only very exposed.
7	Sidi Gaber	Both sheltered & exposed situations.
8	Sporting & Celeopatra	Somewhat exposed.
9	Ibrahimia & Camp Cesar	Somewhat exposed.
10	Shatby	Exposed.
11	East Harbour	Sheltered.
12	Water-Breaks	Very exposed.
13	Anfoushy & Fish Ring	Somewhat sheltered.
14	Mex	Sheltered.
15	West Harbour	Very sheltered.

Stations (1, 14 & 15) in the above table are barren, with the exception of some species of *Enteromorpha* and *Cladophora*. This

may be attributed to the effect of the brackish water prevailing at those places. Stations (1 and 14) are at the shallow outlets of the lakes which receive slightly brackish waters from drains running down through the Delta of the Nile; whereas Station (15) is affected by fresh water pouring out from the Mahmoudia Canal into the sea.

The shore is in part shallow and sandy, in part steep and rocky. It is characterised by several small bays scattered along its length and delimited by projecting rocks which form situations both exposed and sheltered, according to the wind direction such as at Mandara, Stanley and Sporting.

The rocks at Abu Qir (St. 2) are uneven (pl. I fig. 1) and thereby harbouring a good number of species.

At Asafra (Mandara St. 3) there is a projecting rock sloping gently into the sea N. & N.E., and steeply sloping N.W. with crevices all over its surface and thus affording an excellent habitat for the more delicate algal forms particularly by the advent of spring. Here also *Nemalion helminthoides* flourishes best on the bare parts of the pointed rocks, at that time.

At Sidi Bishr (Bir Masoud St. 4), where the shore is rocky with high steeping cliffs, and where the sea is more or less rough, there is a supralittoral belt formed on the top of the rocks, 10 feet higher than the level of water. There one meets *Gelidium pusillum* and *Enteromorpha* associations in winter and spring. In this locality, conditions are also favourable for the existence of tidal pools and isolated pools (pl. 1, fig. 2).

Further to the west, the littoral belt between Sidi Gaber (St. 7) and Silsila (Shatby St. 10) is shallow and more or less rocky. This region is fully exposed to the N.W. winds whose violence is clearly illustrated by the enormous quantities of *Coulerpa prolifera* and other castup algae drifted and accumulated along the shore, particularly at Shatby.

The East Harbour "Old Harbour" (St. 11), however, is sheltered from the sea on the E. & N.E. by the artificial Water-Breaks and the peninsula of Silsila, and on the N.W. by a long projection of land on which Kayet Bay Citadel now stands. On this land too, stand the sewage pumps pouring far out into the sea.

The artificial Water-Breaks (St. 12) exhibit a very exposed situation with forms favouring rough water conditions e.g. *Gelidium*, *Pterocladia*, *Porphyra*, *Corallina* and *Nemalion*. The shore at Anfoushy (St. 13) is sandy except for the few scattered rocks. At that place, the habitat is favourable for the growth of marine phanerogams.

One of the outstanding topographical features of this region is the occurrence of a series of islets extending a short distance off the shore, from Abu Qir to Mex. These islets are the tops of cliffs which were formerly connected with the land and which

subsided as a result of a depression that took place in the Neolithic period (Jondet, 1916). The distribution of the algal flora in these islets is similar to that prevailing on the littoral belt, whenever the bathymetric conditions are alike. One of the most distinguished of those islets is Gezeiret-el-Dahab standing out at a distance two kilometres away in front of Sidi Bishr.

The rocks on the shore are of oolitic sand-stone. They are sculptured with small and fine holes as a result of erosion, thus affording excellent domains for algal attachments as at Abu Qir, Sidi Bishr and Fish Ring to the N.W. of Kayet Bay (Stations, 2, 4 & 13 respectively). Sometimes, however, the rocks are flat and smooth; nevertheless, the discs of *Cystoseira* and *Sargassum* have been able to attach themselves there.

Abrupt slopes of the littoral rocks are few and are met with at Sidi Bishr and Mex, otherwise the slope of land is not so steep. In some places this slope of land gradually ceases and thus giving way to an almost flat shore. The result of this is the extension in breadth of the littoral belt between tide marks to almost over 30 metres as is the case near the Fish Ring and at Abu Qir. In such places a characteristic flora predominates consisting mainly of *Spyridia filamentosa*, *Laurencia papillosa*, *Padina* and *Cystoseira* associations, flora resisting periodic desiccation and intense solar radiations.

According to the charts at the Hydrobiological Station, the 100 fathom line is considerably far from the shore. At 29° 55' E.L., north of the East Harbour which is one of the nearest points to the shore, it is just over 20 kilometres. The East Harbour itself is about 8 fathom deep in the centre.

As for the nature of the sea bottom outside Alexandria, it is either sandy or muddy sand with luxuriant growth of *Caulerpa prolifera*, *Halimeda Tuna* and some sea grasses (Steuer 1935). The muddy nature of the sea bottom outside Alexandria is due to the effect of the River Nile pouring at Rashid and resulting in the settling down and deposition of the colloidal clay particles by the ionised dissolved salts present in the sea water.

III. The Factors Affecting Vegetation

A. Physical Factors

a. Meteorological:

The region of Alexandria has less disturbed weather, smaller rain fall and higher temperature than other regions further west in the Mediterranean.

In April–November the prevailing wind is northerly, except practically for the hot dry S.W.–S.E. Khamasin currents that blow during April and May. The frequency of occurrence of such depressions varies from about 3 to 5 per year.

The wet period of the region usually extends from December to March when the prevailing winds become cold westerly. The rain fall amounts to 188 mm. per year as shown from the records of the Physical Department, Ministry of Public Works, during the period 1901-1934.

Over the whole year, on the average, the region is characterised by a clear sky with no appreciable amounts of clouds (mean cloud amount is 3.4 on the scale 0 to 10). The bright sunshine is 75-80% for over 9-11 hours daily.

The mean relative humidity is greater in summer than in winter. It averages to about 73% in summer & 64% in winter.

From December to March the sea is warmer than the air, while from May to September, the air temperature tends to be slightly higher than that of the sea.

During June and July the temperature of the air rises to about 30° C, under which the intertidal algae suffer from exposure and desiccation for long or short periods according to the tides.

Preliminary experiments have been made during June, on the drought resistance of some intertidal algae inhabiting the littoral belt. It was found that the algae which grow high up on the shore as *Laurencia* resist desiccation to a better extent than those growing near the low water mark such as *Cystoseira*. The loss of water by the latter is more rapid than in the case of *Laurencia*, when both are left to desiccate in air under the same conditions. Losses in weight of about 25% and 30% of the total water content were recorded for *Laurencia papillosa* and *Cystoseira crinita* respectively during a period of 2½ hours exposure to air.

b. Water Temperature:

Table II shows the mean monthly temperature of the surface water as compiled from the thermograph records, set in the East Harbour to register temperatures at 1.2 m. deep near the Hydrobiological Station. Readings of the thermograph were occasionally checked with the readings of a sensitive thermometer and were found to be more or less concordant.

The above figures together with others from other sources, show:

1. That the maximum water temperature at Alexandria (25.5° C) is reached in August and September. This is 1.8 C° higher than Cherchell in Algeria (Feldmann 1931a).
2. That the minimum water temperature at Alexandria (15° C) is reached in February. This is 1.3° C lower than that reached at Cherchell in the same month. February seems in general to have the lowest water temperature in the Mediterranean, while August has the highest one.

Table II
Mean monthly temperatures of surface water at
Alexandria in 1943.

Month	Temp.	Month	Temp.
January	16.2 ° C	July	24.5 ° C
February	15.0 ° C	August	25.5 ° C
March	17.5 ° C	September	25.5 ° C
April	18.0 ° C	October	24.0 ° C
May	19.5 ° C	November	22.5 ° C
June	22.8 ° C	December	19.0 ° C

3. That the avrage water temperature at Alexandria for all the months of the year is 20.8° C.

In Alexandria the more or less wide range of temperature during the year varying as the above table shows from 15° C in winter to about 25° C in summer, has initiated the appearance of a heterogeneous flora of both tropical and boreal affinities in addition to the prevailing cosmopolitan types. Thus of the tropical forms mention may be made of:

Digenea simplex	Anadyomene stellata
Caulacanthus ustulatus	Spyridia aculeata
Acanthophora Delilei	Acetabularia Mobii
Halimead Tuna	

While of the boreal forms which one meets particularly during the winter, species such as *Bangia fusco-purpurea* and *Nemalion helminthoides* may be mentioned.

Temperature and algal periodicity:

As regards the effect of water temperature on the growth and periodicity of algae, the latter are divided into *Eurythermal* and *Stenothermal*. The former can withstand considerable temperature variations and include most of the algae as *Ulva*, *Enteromorpha*, *Laurencia* and *Ectocarpus* inhabiting the littoral belt. The latter can live in deep water, where daily changes in temperature are not so prominent. As examples of those in our water *Halymenia* and *Chrysymenia* are quoted.

As regards the behaviour of our algae towards temperature variations during the seasons, the perennials begin their growth in the late winter and continue growing happily on a rising curve during winter and spring. By the advent of summer, i.e. with the gradual rise in temperature, the rate of growth is not

only retarded but it gradually ceases until by the end of summer, and in autumn plants like *Acanthophora Delilei*, *Laurencia*, *Cystoseira* and *Rytiphloea* shed off their stalks. The retardation of growth of these plants, apart from being a direct effect of the rise of temperature during summer, is also intensified by the growth of epiphytes which start to invade the stalks of the host a few months before.

As for the annuals, their growth profusion follows generally the increasing temperature curve with an optimum growth, in the early spring, after which the rate of growth usually falls. As a matter of fact, during the early spring, species of *Poly-siphonia*, *Bryopsis*, *Asterocystis*, *Ceramium*, *Colpomenia*, *Scytosiphon*, *Hydroclathrus*, *Punctaria* and *Nemalion* reach a high point of abundance on the littoral belt. They begin to disappear, however, as the temperature increases in the early summer till most of them vanish altogether by the end of July. *Scytosiphon*, on the other hand, which flourishes in well defined belts, disappears by the end of May. *Nemalion*, is differed to the end of June, when it begins to decay and is then encrusted by *Calothrix parasitica* as has been noticed at Sidi Bishr (Bir Masoud) and Asafra.

Colpomenia sinuosa and *Hydroclathrus clathratus* growing on the littoral, and sublittoral belts, disappear altogether from the former belt in summer; but continue growing in the latter belt where conditions of life are more favourable.

Ectocarpus Mitchellae, whose life span is short and the spore output is great and continuous throughout the year, migrates during the summer into the sublittoral belt; where it grows luxuriantly on *Posidonia* leaves.

c. Light:

Apart from being an essential factor for plant life, light is probably one of the most important factors in determining the distribution of marine algae.

According to Atkins and Poole (1926) a part of the incident light is lost at the surface of the water due to reflection. The lost part varies between 5 and 30% of the total light depending on the state of the sea. As light passes through depths of water its intensity gradually decreases as certain parts of the spectrum are more and more absorbed with the increase of depth in penetration. Gail (in Atkins 1926) reports a decrease to about 10% of the total light at a depth of 10 metres below sea level and to about 0.4% at 100 metres.

As a matter of fact, red and infra red radiations are absorbed to a much greater degree than the blue or violet rays i.e. longer waves are easily absorbed than shorter ones.

In the light of these facts, the colours of algae have been considered. According to the theory of Gaidukow (1904); material

which is genotypically pure is coloured red in blue light and blue in red light.

Some experimental work has been carried out to determine the effect of different light intensities on different algae by measuring their assimilation activities.

Several workers have measured the assimilation of certain algae under varying light intensities. As a result algae are thus divided according to their optimum assimilation, whether attained at high or low light intensities, into sun-loving and shade-loving forms in analogy to land plants.

Hyde (1938) working out on *Fucus serratus* called attention to the fact that both light and temperature factors go together in determining the "light place" of this alga. She found as far as the temperature alone is concerned, that the rate of apparent assimilation rises with rise of temperature; a maximum is reached at about 25° C. If the light intensity is low a first maximum is reached at 5° C. after which there is a drop in assimilation activity followed by a second maximum at 25° C also. As far as the effect of light is concerned, she found that increase in light also increases the assimilation activity so long as the temperature is not limiting. Assimilation continues to rise with the increase of light up to the equivalent of $\frac{2}{3}$ total day light (16,000 lumens). On the basis of such experiments the algae living on the littoral belt are certainly sun-loving plants.

It is necessary to add here that light intensity on our shores is great as has been referred to above. Some of our algae living on the littoral belt, which can withstand such bright sunlight, are flourishing well in summer, such as *Ulva*, *Enteromorpha*, *Laurencia* and *Pterocladia*. The Phaeophyceae in general favour sunny places with shallow water. The following algae grow luxuriantly in summer in littoral pools at Sidi Bishr and Abu Qir: *Padina Pavonia*, *Ectocarpus Mitchellae*, *Halopteris filicina*, *Sphacelaria cirrosa* & *Cystoseira* sp.

Forms such as *Halymenia* & *Chrysomenia*, are found actually in deep waters and are scarcely found on the littoral belt.

There are forms, however, which though favouring dim situations and of a more or less delicate structure, sometimes occur on the littoral belt. These are met with in sheltered places under projecting rocks and in crevices, where they do not fall under the direct effect of the bright light. *Cladophora pellucida* is an outstanding example, always found on our shores hanging down from the overarched roofs of submerged rocks, a feature in exact accordance with Feldmann (1937).

Other Chlorophyceae favouring dim situations are *Udotea petiolata*, *Halimeda Tuna*, *Chaetomorpha aerea* & *Udotea minima*.

In crevices and under projecting rocks of the lower littoral and the upper sublittoral belts, the following forms are never

mistaken and are found together in an association at any time of the year, particularly at Abu Qir, Asafra and Sidi Bishr:

Botryocladia botryoides
Phyllophora nervosa

Rhodophyllis bifida
Valonia utricularis

Light intensity sometimes affects the growth form of certain individuals. *Botryocladia botryoides*, a shade-loving plant, changes its growth form as it grows deeper into the cave where the light becomes gradually weaker. The shape assumed by the innermost individuals is more robust and the plants appear more densely crowded.

Light also affects the development of the colouring pigments of marine algae, to an extent that these plants which are exposed to intense sun-light become bleached. The forms growing high up on the littoral belt are almost bleached in summer e.g. *Ulva*, *Enteromorpha* and *Laurencia*. Some Rhodophyceae growing in calm situations; such as *Spyridia filamentosa* & *Laurencia obtusa*. The same species, if they happen to grow in situations exposed to strong dashes of waves, are deeply coloured, a phenomenon observed by several other workers.

The same plant may even be partly bleached and partly coloured due to differential exposure to light. This is demonstrated by *Gracelaria* growing under a projecting rock at Asafra in the late spring. The parts protected by the rock are deep red with a stunted form; whereas those growing outside the rock and exposed to direct intense light are almost bleached.

Epiphytes seem to prevent the bleaching effect of light on the host, especially when they form a dense covering over it. Parts of *Rytiphloea tinctoria* and *Laurencia* masked by such a covering epiphytes (mostly *Jania rubens*) were found unbleached, whereas the epiphyte *Jania* itself was feebly coloured.

d. *Water Movements:*

The amplitude of tides at Alexandria is very small compared with that of other places such as the Red Sea or the Ocean. The Admiralty Hydrographic records show that tides at Alexandria vary from 20—30 cms., whereas according to Nasr (1939c) the tide reaches at Ghardaqa on the Red Sea about 120 cms.

Such a low tide together with the steep slope of the rocky parts of our shores causes the littoral belt at such places to be a narrow one, characterised by more or less overlapping associations.

As for the state of the sea, it is given in Table III compiled by the Admiralty Hydrographic Office from readings taken between 1907—1919 at Abu Qir.

Table III
State of the Sea at Abu Qir

S t a t e	Days per 100
Rough or high ...	2
rather rough	2
moderate	6
slight	16
very slight	23
calm	51

The figures in the table are safely considered as average indications of the general state of the sea in that region. They show that during over 75% of the year, the sea is either calm or very slightly rough, whereas only 4% of the days are characterised by a rough sea. It seems that this percentage of roughness is almost grouped in winter. In contrast to this, however, and according to our observations, there are certain places such as Bir Masoud at Sidi Bishr, Stanley Bay rocks and Kayet Bay, where the sea is usually rough in winter. In such places, particularly, where there are high steep rocks extending above the level of the sea, the strong dashes of waves make conditions favourable for the existence of a supralittoral belt and isolated pools as well.

Irregular disturbances of the water in the coastal region are occasionally met with particularly in places where there are deep hollow rocks as at Sidi Bishr. These disturbances are also sometimes caused by the prevailing winds and often form local currents. Such currents are a characteristic feature of our shore and are responsible for the distribution of algae by carrying spores from one place to another. The sporadic appearance of species like *Punctaria latifolia* and *Nemalion helminthoides* in certain localities is due to such currents. They help in carrying nutritive salts from places of higher to others of lower concentration, thus favouring algal growth. They assist in establishing new substrata on top of vegetation already existing as observed at Sidi Bishr and Abu Qir. By the end of summer and during autumn these water currents carry sand and deposit it on the *Cystoseira* association, whose stipes hold it with a more or less firm tenacity. *Caulerpa prolifera* with its greatly ramified stolons then first establishes itself in this new substratum, and subsequently helps in its further formation and stabilisation, thus paving the way for more delicate forms such as *Pterosiphonia pennata*.

Water movements characteristic of exposed places cause aeration and renewal of dissolved nutrients. Individuals such as *Valonia utricularis*, *Gelidium* and *Pterocladia*, under such conditions are usually more robust than those in calm situations.

B. Chemical Factors.

Although the open sea water has a homogeneous constitution throughout, yet the composition of our estuarine and inshore waters is, to some extent, affected by certain factors which make it vary from one place to another. Thus at certain sites in our shore near Alexandria, where there is plenty of waste material pouring out into the sea, the amounts of nutritive salts and organic matter increase affecting at the same time, to a slight extent, the hydrogen ion concentration. At the outlets of the branches of the Nile (near Rashid and Domiat) together with the lakes, the salinity of the water is somewhat reduced by the fresh water of the Nile and the brackish water of the lakes. This effect is manifested by the abundance of such Chlorophyceae as *Ulva* and *Enteromorpha*.

During a visit to the Eastern Egypton Shores of the Mediterranean (October 1944) up to the boundaries between Egypt and Palestine, the writers have had the chance of noticing the effect of the Nile on the algal flora. Water currents drift the flood water to the north and north east directions. The inshore brackish water is to be met with up to about 40 kilometers east of Ras-el-Bar and can hardly exceed this point. The coast along this distance is markedly poor, possibly due to the mud of the River Nile being deposited on the shore and rendering the substratum unfavourable for algal growth; and to the reduced salinity of the water to an extent that makes it unfavourable for the growth of marine algae. In places where the substratum is more or less favourable e.g. remains of old walls, big stones, fixed iron bars and woody boards etc., brackish water-forms such as *Ulva* and *Enteromorpha* are common. At Port-Said, however, almost pure sea water predominates rendering a suitable habitat for normal algal growth of both Mediterranean and Red Sea types. The assumption put forward by Carmin (1934) that the abundance of *Ulva* and *Enteromorpha* at Java (Palestine) is due in part to the effect of the Nile water, could be met with some suspicion unless we admit that Port-Said itself is sheltered from the currents of the river, which go to the north and north east.

a. Salinity:

Our shores present excellent grounds for studying the effect of salinity on algal profusion and distribution. This is due to the effect of the fresh water of the River Nile and the brackish waters of Idku & Maryut lakes which pour out into the sea at different places some distance away from each other.

The waters of Lake Idku & Lake Maryut are brackish. Their salinities vary in a wide range according to the locality and season. The mean salinity in different four stations in both lakes during the year 1943 is given in the following table:

Table IV
Mean salinity of 4 stations in lakes Maryut & Idku during the year 1943.

Station	Maryut	Idku
I	8.17 ‰	17.32 ‰
II	8.92 ‰	18.06 ‰
III	10.59 ‰	12.72 ‰
IV	8.33 ‰	2.78 ‰
Mean	9.00 ‰	12.72 ‰

The figure tabulated for each station corresponds to the mean of 4 readings taken throughout the year.

The above figures show that the mean salinity inside the two lakes is very low (9—13‰). This is illustrated by the scarcity of algae inside the lakes, where only few Cyanophyceae, together with *Ectocarpus tomentosum* epiphytic on *Phragmites* (collected in April 1945) could survive.

On the other hand plenty of water plants and halophytes predominate e.g. *Lemna*, *Ceratophyllum*, *Salicornia*, *Suaeda* and *Phragmites*. The water at the outlet of Lake Maryut and at places extending west to the lake was analysed for salinity determinations together with the determinations of nutritive salts and hydrogen ion concentrations. The results are given in the following table:

Table V

Locality	Salinity	pH	NO ₃	NO ₂	PO ₄
St. II	17.65 ‰	8.1	40 mgs/m ³	8 mgs/m ³	40 mgs/m ³
St. III	23.73 ‰	8.3	30 mgs/m ³	5 mgs/m ³	25 mgs/m ³
St. IV	38.35 ‰	8.4	—	—	—

From the above table the salinity of the water is very low near the outlet of the lake (where it is only about 8‰ at St. II)

and increases gradually as we go further away from the lake until it reaches the normal figure of 38.4⁰/₀₀ at a distance of about 800 metres (St. IV). As for the pH, the variation is very small, 8.1—8.4. As for the nutritive salts, Station II is richer than Stations III & IV.

The bearing of the above figures on algal distribution in these localities could be understood from the following observations.

Station I at the outlet of the lake was totally barren, except for few floating water plants. (e.g. mostly *Ceratophyllum*) brought about by the streaming water.

At St. II the littoral belt appears to show signs of colonisation by poor vegetation of *Enteromorpha*, *Cladophora* and *Ulva* which become more and more intense as we go further to the west till we reach Station III. Here conditions are favourable for the appearance of some brown and red forms (e.g. *Gelidium crinale*, *Cystoseira*, epiphyted with *Rhodochorton* and some *Cerallina*), together with a dense vegetation of *Enteromorpha* and *Ulva*.

At St. IV and further to the west the conditions are optimum for the development of algal associations as to be met with in other localities having normal sea water.

As to the distribution of algae similar observations were made in places extending to the east and west from the outlet of Lake Idku. Combining the analysis of figures in the above table with the algal profusion at the same stations, we can see that the factor that suggests itself to play the major part is the salinity. The algal distribution follows generally the increasing salinity figures, whereas the hydrogen ion concentration and the nutritive salts could not be considered as limiting factors in this particular case. The water at stations far away from the effect of the fresh water of the Nile and the brackish water of the lakes was also analysed and its salinity was determined. The results are given in the following table:

Table VI
Salinity values at different stations near Alexandria.

Date	Locality	Salinity
12/10/1943	East Harbour	38.73 ⁰ / ₀₀
18/10/1943	Abu Qir	38.71 ⁰ / ₀₀
23/12/1943	Sidi Bishr	38.42 ⁰ / ₀₀
10/ 4 /1944	Stanley Bay	38.53 ⁰ / ₀₀
10/ 5 /1944	Camp Cesar	38.39 ⁰ / ₀₀

The above figures show that the salinity values are almost constant; they show but slight variation from one place to another. At these stations pure sea water predominates; they are characterised by a rich algal flora especially at the exposed localities.

From the above, it can be safely gathered that salinity has a great influence upon algal life, inasmuch as it affects the distribution of algae in different waters containing different concentrations of NaCl.

The algae inhabiting our shores could thus be divided according to the variation in salinity as follows:

1) Plastic forms occur in waters with both low and high salinities e.g. *Enteromorpha*, *Cladophora*, *Ulva* and *Ectocarpus tomentosum*. These might as well possess an optimum salinity which differs according to the different species. Below a certain minimum value of salinity which in our case could be considered as about 12‰ even those forms which can live in low salinity could not exist. At 23‰ only few other forms like *Gelidium crinale* which flourish well in normal sea water can survive.

2) Certain forms exist in normal sea water with a normal salinity of about 38.5‰. Under this category lies the majority of algae inhabiting our lower littoral and upper sublittoral belts.

3) Few forms live in waters of normal salinity and super-saline waters, as certain forms inhabiting the isolated pools, as *Platymonas tetrathele* under salinity of about 60‰.

b. *Hydrogen ion concentration*:

The following table gives the results of the pH determination in the different localities by the colorimetric method.

Table VII

Date	Locality	pH
29/10/1943	Asafra	8.3
13/11/1943	Sidi Bishr	8.7
26/11/1943	Mex	8.4
24/12/1943	Sidi Bishr	8.2
27/10/1943	East Harbour	8.3
3/11/1943	" "	8.8
28/11/1943	" "	8.3
23/12/1943	" "	8.6
29/12/1943	" "	8.4
18/5/1944	" "	8.7

As seen from the above table, the pH of the inshore water of Alexandria ranges from 8.2—8.8, whereas in the open sea it is more constant varying between 8.1—8.3. This is certainly due to such factors as plant activities, seepage of water, plant and animal refuse; factors producing wider variations in pH had it not been for the buffer action of the sea water.

The figures for the East Harbour show the same wide variations, raising the pH at certain times of the year to 8.8. This may be due to the richness of water in nutritive salts which would favour the development of a good number of algae.

The biological importance of the study of the hydrogen ion concentration of the medium in which marine algae live is closely related with the interaction of factor in this particular medium. The effect of alkalinity is more prominent in small masses of water such as those reserved in littoral pools rather than in the open sea.

Feldmann (1933) studied the variations of pH in littoral pools inhabited by Chlorophyceae such as *Enteromorpha*, *Cladophora* and *Chaetomorpha*. He came to the conclusion that the alkalinity rises from 8.1—9.4 in one of those pools as the temperature rises from 10—25° C during one and the same day. This variation in alkalinity, however, was much less in the upper sublittoral pools where renewal of water is more rapid.

This wide range of variation in alkalinity characterising the littoral pools acts in harmony with other factors, such as temperature, light, salinity etc., in limiting the number of species inhabiting such pools. For example, delicate forms such as *Falkenbergia*, *Callithamnion* etc. which flourish well in the upper sublittoral pools on our shores are altogether lacking in such littoral ones.

Moreover, R. Lami (1934), found that even in the same pool the pH is not homogeneously distributed. Forms like *Enteromorpha*, for example, which are characterised by active metabolism cause an elevated pH in the water just surrounding the individuals. He then tried to explain the specialisation of certain hosts towards epiphytism on the light of such alkalinity determinations. He postulated that the high alkalinity resulting from the active metabolism of certain forms might inhibit the growth of epiphytic algae on such forms.

c. Organic Matter:

The East Harbour in Alexandria is perhaps one of the richest spots in organic matter on our shores. Steuer (1935) found it to contain 590 grams fresh weight of organic substance per cubic metre. This is naturally due to the fact that sewage pumps of the city pour out into the sea in a spot very near the East Harbour which also forms an almost closed large basin. Judging from Vatova statement in 1931 that the figure 800 grams of organic

matter per cubic metre found by him in the lagoons of Venice is the highest figure so far recorded in the Mediterranean; the East Harbour stands out as one of the rich places in that respect.

Several workers have observed that certain species of algae favour habitats rich in organic matter; *Pobysiphonia variegata* being a typical one. The writers have come across dense growth of this species epiphyting on *Zostera* in the Western side of the East Harbour; where the substratum is favourable for the growth of *Zostera* itself. *Ulva Lactuca* and *Caulerpa prolifera* grow luxuriantly in the East Harbour and in Abu Qir Bay.

In littoral pools during the summer when the rise of temperature together with other conditions become unfavourable for the growth of the algal forms present in these pools, the dead putrifying bodies of those algae raise the organic content of the pool. Under such unfavourable conditions of high pollution, the writers have observed the presence of certain Cyanophyceae such as *Lyngbya* and *Phormidium*.

d. Nutritive Salts:

In addition to the other essential elements of plant growth which are found in abundance as ionised dissolved salts in the sea, nutritive salts stand out as those inorganic compounds of the elements N, P and Si in the form of nitrates and phosphates, and to a lesser extent in the form of nitrates and soluble silicates. They are present in very minute amounts in the sea and seem to follow a definite cycle closely related with the organic life. They are indirectly affected by the physical conditions of the medium such as temperature, light and depth of water.

Their importance to plant life has been pointed out by many authors. Brandt (1929) carried out an extensive work on the nutrition and growth of plankton algae under varying conditions and applied the law of limiting factors on their growth and multiplication. He pointed out the importance of these salts in governing the richness or even barrenness of any locality.

Atkins, in his study of the phosphate determinations in the English Channel between 1923—1926 found that there is a close correlation between the content of phosphate in these waters and the profusion of growth of phytoplankton. According to his determinations the phosphates fluctuated widely in the different seasons and in different parts of the sea. When the phosphate concentration decreases to about 5 mgs/m³ plankton growth falls down to a minimum.

Since 1923 great improvements have been introduced to the method of experimental research in that line regarding the methods of determinations of nutritive salts. This has paved the way for an intensive work on the marine fertility specially in relation to the demands of phytoplankton.

In the following pages, determinations of these nutritive salts

namely nitrates, nitrites, phosphates and silicates in some places on our shores are tabulated and briefly discussed. The estimation of nitrates and phosphates are undertaken in the East Harbour; their bearing on the plankton cycle is dealt with. Observations on the morphological features displayed by some of the algal species inhabiting this locality associated with the above determinations are also made.

Results

Table VIII

Date	Locality	Nitrate	Nitrite	Phosphate	Silicate
22/10/1943	Abu Qir	10 mgs/m ³	poor	15 mgs/m ³	336 mgs/m ³
24/10/1943	East Harbour	40 "	12 mgs/m ³	30 "	1000 "
20/10/1943	Mandara	10 "	poor	poor	poor
3/11/1943	East Harbour	15 "	8 mgs/m ³	40 mgs/m ³	over 800 "
14/11/1943	Sidi Bishr	18 "	poor	20 "	" 800 "
12/11/1943	East Harbour	40 "	12 mgs/m ³	85 "	" 1000 "
26/11/1944	Mex	40 "	8 "	40 "	very high
28/11/1944	East Harbour	30 "	—	20 "	high
26/12/1944	Sidi Bishr	15 "	4 mgs/m ³	30 "	over 1000 mgs/m ³
25/12/1944	East Harbour	60 "	10 "	100 "	over 1500 mgs/m ³

Table IX

Mean monthly determinations of Phosphates and Nitrates in the East Harbour for the year 1943—1944.

Month	Nitrates in mgs/m ³	Phosphates in mgs/m ³
September	18	41
October	22	40
November	60	81
December	52	90
January	50	50
February	33	60
March	25	37
April	20	70
May	10	25
June	8	10
July	21	10

Table X
Seasonal variations in the amount of Nitrates and Phosphates
in the East Harbour for the year 1943—1944.

Season	Nitrates mgs/m ³	Phosphates mgs/m ³
Spring	26	56
Summer	10	15
Autumn	20	40
Winter	54	74

Table VIII shows the amounts of nutritive salts of Abu Qir, Mandara, Sidi Bishr and Mex compared with those of the East Harbour is markedly richer in those nutrients than any of the other places. Nevertheless, nutritive salt concentration in these places is quite enough for normal growth of plant life.

The plankton cycle in Alexandria is greatly influenced by the seasonal variations in nutritive salt concentrations given in Table IX. In fact the East Harbour occupies a unique place as regards its fertility.

Steuer (1935) had undertaken monthly determinations of the amounts of plankton, including both phytoplankton and zooplankton at Alexandria from April to November during the year 1933. Accordingly, during the summer i.e. from June to August the plankton catches show a very marked poverty (less than 1 c.c. gross volume of plankton). He stipulates also that this amount begins to increase till it attains a maximum in October (reaching about 25 cc. in mid October, a sample which contained almost exclusively phytoplankton).

The important series of experiments carried out by Atkins (1923–1926), Harvey (1926) and Cooper (1933) have shown that there is a cycle in the amount of nutrient salts corresponding with the cycle of phytoplankton.

Table IX of the present series of determinations shows the mean monthly amounts of nitrates and phosphates in the East Harbour.

Compiling the data in Table IX in a more concise way we obtain Table X. In this table the mean amount of every three successive months is obtained. Thus we get 4 readings for each salt corresponding with the 4 seasons of the year.

Fig. (1) is a graphic representation of the figures in Table X. The graph shows a maximum concentration of both phosphates and nitrates in water (74 mgs/m³ and 54 mgs/m³ respectively) and a minimum concentration in summer (15 mgs/m³ and 10 mgs/m³).

These maxima and minima correspond to a great extent with the maximum plankton catches obtained by Steuer.

The interpretation of such cycle on the light of nutrient de-

termination is easy to explain. As already stated before, the end of summer and the early autumn are considered as dead seasons with regard to algal activities.

The amount of nutrient depleted during the summer is replenished in the late autumn and early winter, at least, partly by the organic products accumulated from the decayed algae and other organisms. Since the life cycle of plankton is very rapid with regard to that of higher algae, the maximum production of plankton precedes the maximum reached by other algae, and we are left at least with 2 maxima: one for plankton in early winter and the other for higher algae in spring as referred to before.

Nutrients and other algae.

Of the algae inhabiting the East Harbour other than plankton, the *Ulvaceae* are very well developed specially *Ulva Lactuca* found on the muddy substratum. It attains a great length not reached by the same species growing in other localities of the district.

Gracilaria confervoides, is another example of such enhanced vegetative growth. Specimens gathered in February from the same locality exceed 140 cms. in length. The different growth forms of such species are but ecological aspects of the different habitats. This extraordinary vegetative growth of *Ulva Lactuca* and *Gracilaria confervoides* may be due to the effect of nutritive salts specially to that of nitrates, in support of Cotton's (1911) and Foster's view (1914).

IV. Epiphytism

A. *Biological behaviour:*

Epiphytism among algae is in most cases a result of competition among different individuals failed to find a space in a favourable substratum.

To illustrate this phenomenon an example is given of a locality at Sidi Bishr, where the topographical features of the substratum in the upper sublittoral belt favour indirectly the growth of many epiphytes. In that locality there are depressions in the rocks covered with sand and mud, the tops of these rocks only remaining bare. Since the rocky substratum is an excellent ground for algal attachments, it is not strange then to find these bare parts totally covered with a dense vegetation. The forms that constitute the rocky formation in this locality are mostly of the perennial types comprising *Cystoseira*, *Sargassum* and *Halopteris* associations. The alternation of seasons brings about many lower algae which owing to such dense population of perennials find no direct attachment to rocks. Soon they establish themselves on the thalli of those perennial forms. It is interesting to mention that these comers display a more or less regular order in colonising the stipes of their hosts. The robust forms succeed in establishing themselves first and are then followed by the

more delicate forms which attach themselves either to some shaded parts of the original host or to the robust epiphytes themselves.

Halopteris filicina illustrates a good example of a generous host. *Jania rubens* comes first and is then succeeded by the more delicate forms such as *Heterosiphonia Wurdemanni* & *Callithamnion*.

During August the following epiphytes were found on a *Halopteris* plant from the above locality:

<i>Jania rubens</i>	<i>Ceramium tenuissimum</i>
<i>Heterosiphonia Wurdemanni</i>	<i>Dictyota dichotoma</i>
<i>Callithamnion corymbosum</i>	<i>Melobesia farinosa</i>
<i>Hypnea musciformis</i>	<i>Ectocarpus</i> sp.
<i>Polysiphonia</i> sp.	<i>Rhodochorton</i> sp.
<i>Erythrotrichia</i> sp.	<i>Chaetomorpha aerea</i>

The growth of these epiphytes becomes so crowded and dense that it causes the death and deterioration of the host plant itself at the end of the season (generally in autumn).

The reason of succession in colonisation of these epiphytes is difficult to explain. It may be due to the ease with which the spores of the secondary epiphyte could attach themselves to the bodies of the first invaders, or to the protection afforded to them.

Some workers claim that this special arrangement of epiphytes on the host is mainly due to the effect of light.

Boergesen (1905) attributed such differential arrangement of epiphytes on the host to light.

With regard to the behaviour of epiphytes towards the different hosts there are specialised types & indifferent types.

The former category comprises the types specialised to certain hosts. As an example, mention may be made of *Ascocyclus orbicularis* found on the leaves of *Posidonia*. It was separated from *Ascocyclus Magnusii* living on the leaves of *Zostera* by Sauvageau (1927) on account of such behaviour. Also *Giraudya sphaclarioides* is not found except on the discs of *Ascocyclus orbicularis*; *Calothrix parasitica*, *Rhodochorton Nemalionis* and *Polysiphonia tenerrima* on *Nemalion*.

Under the latter category lies the majority of epiphytes which are facultative on *Laurencia*, *Cystoseira*, *Digenea*, *Halopteris*, *Halopitys* and *Rytiphloea*.

Jania rubens, a widely indifferent epiphyte, is sometimes found forming a matrix covering all the algae inhabiting the sublittoral belt in a good number of localities.

As regards the mechanism of attachment, the epiphytes may adhere to the host plant by a small disc as in the case of *Jania*, or hapters as in many members of the Ceramiales especially the creeping forms, or rhizoids as in the case of *Hypnea*. In cases

where the basal parts of the epiphyte penetrate into the cortical parts of the host we speak of partial endophytism. This latter case applies to *Rhodochorton* on *Cystoseira* and *Calothrix parasitica* on *Nemalion* at Sidi Bishr.

B. Susceptibility of host to epiphytes:

As to the susceptibility of the host to the epiphyte, it depends largely on the nature of the surface of the host itself. It is greatly favoured by the roughness of the surface, or the presence of spines as in the case of *Acanthophora*, or the presence of utricles as in the case of *Codium*. The verticillate branches of *Halopteris* and the papillose surface of *Laurencia* also offer a good surface for the attachment of spores of *Ectocarpus*, *Jania*, *Ceramium*, *Heterosiphonia* etc. quite in accordance with observations made by Nasr (1939-c).

Plants with a smooth surface like *Caulerpa prolifera* and *Dicthyopteris membranacea* are hardly epiphyted if ever.

Nevertheless, a dense growth of *Rhodochorton* at Kayet Bay and Sidi Bishr was noticed as an epiphyte on the thallus of *Caulerpa prolifera*, due to the richness of the host in pectic material favourable for the attachment of *Rhodochorton*.

As regards the effect of the movements of water on the spread and profusion in growth of epiphytes, it was observed that epiphytes may be dense and profuse in both calm and exposed situations, depending naturally upon the spore output and its development. In a good number of localities where there is a strong dashing of waves, the *Laurencia*, *Pterocladia* and *Gelidium* associations are densely epiphyted with *Ceramium rubrum*, *Polysiphonia*, *Hypena* and *Rhodochorton* spp.

V. The Vegetation

A. Algal Belts

In accordance with Boergesen's modification on the classification of algal belts, we find *Enteromorpha* and *Bangia* associations extending a few feet above the highest water mark specially in winter and particularly at places such as Sidi Bishr and Kayet Bay. This last belt should not be confused with the independent *supralittoral* belt cut off from the littoral belt by a wide gap of vertical rocks almost destitute of vegetation.

The Littoral Belt

The upper limit of this belt is generally the *Ulva* association, while in certain places, particularly in exposed localities, it is replaced by the *Enteromorpha* association. The lower limit is generally the *Laurencia* association, and in more exposed localities the *Ceramium ciliatum* and the *Centroceras* associations. In

sheltered situations, however, the lower limit may be the *Padina Pavonia* association (pl. II fig. 3) which sometimes merges imperceptibly into the sublittoral belt. In certain places at Sidi Bishr, where the substratum is rocky and mixed with Gastropod shells, *Cystoseira*, is taken as the lower limit of vegetation on the littoral belt.

In fact, exact determination of the vegetation forming the extreme limits of such belt is difficult to define. The temperature and other factors due to the seasonal variations should be taken into consideration as, for example, the associations present in winter, may disappear altogether in summer e.g. *Scytosiphon* belts forming the upper limit of vegetation in winter and spring.

As referred to before, one occasionally meets along the shore flat rocks gently sloping into the sea. In this case the littoral belt could be divided into *upper*, *middle* and *lower* belts.

The littoral belt embodies also the tidal pools, isolated pools & crevices.

1. *Tidal pools.*

These are directly connected with the sea and are characterised by regular renewal of water. Plants inhabiting such pools are suited to exposure and might perhaps, as pointed out by some authors, perform part of their assimilation at low tide.

The following vegetation was met with in one of those pools at Sidi Bishr in summer. At the entrance of the pool, *Chaetomorpha* was seen gracefully moving with water as it enters or comes out of the pool. The tops of the pool were inhabited by *Ectocarpus*, *Sphacelaria* and *Polysiphonia* spp. Then a dense growth of *Caulacanthus ustulatus* and *Gymnogongrus Griffithsiae* associated with *Corallina* and *Amphiroea* live on the vertical ridges. At the bottom, we find *Polysiphonia phleborhiza*, *Ulva* and scattered individuals of *Laurencia papillosa* epiphyted with *Jania rubens*, together with a dense growth of *Padina Pavonia*. In the sand collecting at the corners of the floor of the pool, we find *Pterosiphonia pennata* and *Herposiphonia secunda*.

The dense growth of *Padina* in those pools indicates the ability of that plant to flourish under such conditions of high salt concentration, periodic desiccation and intense solar radiations. On the other hand, while examining some of the *Ectocarpus* specimens collected from such pools, it was found that some reproductive cells, which passed through the early stages of formation of plurilocular sporangia, had changed into vegetative structures. This might be due to the effect of sudden changes in the habitat.

2. *Isolated pools.*

These are found in situations more or less exposed, in a level higher than that reached by the tides and are therefore not in

direct connection with the sea. They are of different forms, some are shallow saucer-like and others are large.

These pools are often inhabited by *Platymonas*, *Enteromorpha*, *Ulva*, *Cladophora* and *Ectocarpus*, sometimes *Spyridia* and some *Cyanophyceae*.

Conditions of life in such pools are extremely adverse, specially in cases when the pool is shallow. If any considerable changes in the environment takes place, as for example a sudden and great rise of temperature accompanied by a rise in the salt concentration, the individuals inhabiting the pool are destined to die. *Platymonas*, however, was found to be able to resist such adverse conditions to a greater extent than the other forms.

3. *Crevices.*

The crevices in both the littoral and upper sublittoral belts offer excellent habitat for the algae which favour the sublittoral belt. In other words, the distribution of the algal flora in such crevices corresponds with a vertical distribution in a wide bathymetric sense. For example, species such as *Halimeda Tuna*, *Valonia utricularis*, *Phyllophora nervosa*, *Botryocladia botryoides* and *Dictyopteris membranacea*, most of which generally live in deep water, were luxuriantly growing in such crevices.

The Sublittoral Belt

The upper limit of vegetation in this belt is the *Cystoseira* association (pl. II, fig. 4) in more exposed localities, and the *Posidonia* or *Zostera* associations in sheltered situations, where the substratum is sandy or muddy sand.

The lower limit of vegetation in this belt is out of the scope of the present work which is mainly confined to a study of the littoral and upper sublittoral algae.

B. Formations & Associations characteristic of the District

a) *Algal Formations:*

The periodicity of algae during the seasons has no apparent effect on the nature of the substratum to which these algae attach themselves. In this respect, the substratum is described as indifferent; and hence the succession of algal vegetation is not towards climax.

The substratum, on the other hand, plays an important part in determining the stature of vegetation in a natural grouping of major parts under the name "formations".

The term "formation" was formerly put forward to stand for "association", and it was not until Boergesen in 1905 had given the correct synonym. It corresponds also with the term "Facies" adopted by Feldmann (1937).

By far, the importance of substratum in the grouping up of vegetation has been pointed out by many authors. According to the nature of the substratum Cotton (1912) divided the vegetation into the rocky shore formation, the sandy and muddy sand formation and the salt marsh formation.

Setchell (1917) gave a proper definition for the formation as "Aggregation of algae of some general form depending particularly upon the substratum".

The formation, however, comprises smaller communities of vegetation called "*associations*" which according to Feldmann (1937) are described as "Caractérisés par une composition floristique dans les différentes localités d'une même région florale".

Nasr (1939-c) defined the association as algal community characterised by its essentially homogenous physiognomy and ecological structure and by its homogenous floristic composition at least with regard to dominant species; this agrees fairly well with Feldmann's. Likewise, the associations studied in the next chapter, follow the above picture of association.

In the light of these views, the formations grouped according to the nature of the substratum, are the following:

1. Muddy sand formation.
2. Shelly sand formation.
3. Rocky formation.

1. *The Muddy Sand Formation.*

This formation is well characterised on our shores by the marine Phanerograms such as, *Posidonia oceanica* and *Zostera marina* in a substratum with more or less foraminefera sand. Leaves and stems of this vegetation offer a haunting place for many algae as epiphytes throughout the year.

When the sandy substratum is protected by rocky ridges, conditions are favourable for the growth of *Caulerpa prolifera* which seems to withstand slight changes in the composition of substratum from clear sand to muddy sand.

This caulerpa association occupies vast areas of the sea bottom at Alexandria and its vicinities. It covers the western part of Abu Qir Bay and extends as such to Mex and even more to the west; it is limited seawardly by the 50 fathom line (Steuer 1935).

Great masses of this association are cast ashore during winter specially near Silsila causing water pollution and harbouring a rich epifauna. The Municipality takes rapid measures to remove these masses and utilises them in making manure.

At Sidi Bishr, in the small lagoon protected eastwardly by the cliffs of Bir Masoud; the quantity of mud in the substratum shows preponderance to that of sand. Conditions there become favourable for the growth of *Dasycladus*, *Halimeda* & *Udotea*. The sea grass *Zostera*, unlike *Posidonia*, favours protected situations with more mud in the sand.

2. The Shelly Sand Formation.

Shell débris mixed with coarse sand form a compact substratum well aerated and densely covered with vegetation. Stolons of *Dilophus ligulatus* easily ramify in such substratum which harbours as well the more delicate forms such as *Acetabularia Mobii*. Moreover the small shells of gastropod offer a fixing place for genera like *Ectocarpus*, *Sphacelaria*, *Polysiphonia* & *Pterosiphonia*.

3. The Rocky Formation.

The major part of algal flora in Alexandria is to be found in such rocky substratum. Details of the associations taking part in the composition of this formation will be discussed soon.

b) Algal Associations:

The following is a study of some associations met with during the period of the present investigation. There are certainly other associations either of less distribution than those mentioned below or common among our flora and that of other authors in the Mediterranean.

For the most part, these associations are determined by the situation, substratum and the bionomical position.

Posidonia oceanica Association

This association generally favours exposed situations with sandy or rocky sand substratum. The vegetative propagation of *Posidonia* is very profuse, and yet it has not been seen fruiting in the environs of Alexandria.

It extends in the upper sublittoral belt, and since great quantities of the plant are cast ashore from the inside, it seems that the plant also lives in deep water.

Heaps of *Posidonia* balls are found at Bourg El Arab in March and April.

During winter, new growths of *Posidonia* emerge to replace the old ones shed away. The leaves are soon incrustated with *Ascocyclus orbicularis* discs and then with *Giraudya sphacelarioides* which last till the end of August. Of the Mesogloioaceae, a dence covering of *Castagnea mediterranea* is seen flourishing and fruiting in March.

During spring also, *Ectocarpus Mitchellae* becomes a dominant species on the leaves of *Posidonia*. In summer, however, *Ectocarpus irregularis*, *Melobesia farinosa*, *Erythrotrichia* spp., *Rhodochorton* spp., *Sphacelaria tribuloides* and *Lyngbya* spp. compete to colonize the *Posidonia* leaves.

Occurrence: Abu Qir, Asafra & Sidi Bishr.

Spyridia filamentosa Association

This association occurs in the middle littoral belt in calm situations, in places where the ground is more or less flat. Rocks in these places are characterised by sharp pointed tips recalling the coral reef flats of the Red Sea; and harbouring small ditches with stagnant water during the summer time. The individuals of *Spyridia* inhabiting those ditches become bleached under the influence of strong illumination and increased temperature. These conditions favour the growth of many diatoms which attach themselves often to the filaments of *Spyridia* and *Cladophora*.

The following species are often present in this association.

- Cladophora sp. (rare)
- Laurencia papillosa (common)
- Padina Pavonia (common)
- Ulva Lactuca (frequent)
- Ceramium ciliatum (autumn) (common)
- Chondria dasyphylla (very rare)
- Laurencia paniculata (fairly common)
- Spyridia aculeata (uncommon)
- Ceramium gracillimum (rare)
- Enteromorpha sp. (frequent)
- Cystoseira sp. (rare)
- Acanthophora Delilei (fairly common)

together with some blue greens and sea anemones.

Occurrence: Kayet Bay & Abu Qir (west rocks).

Gracelaria confervoides Association

(pl. III, fig. 5)

Fronds of *Gracelaria* forming this association are crowded and densely branching reaching 30—40 cms. in length. The association extends from the middle littoral belt where individuals become totally exposed at low tide down to the upper sublittoral belt, where only the tips of the plants become exposed at intervals.

The substratum on which this association grows is rocky covered with sand and shells, a mixture favourable for a complete development of such association. The sand covers the bases of the plants up to about 5 cms. offering at the same time a domicile ground for other algae which seek shelter among the dense growth of this association.

The epiphytes on *G. confervoides* itself are numerous and of these *Ceramium rubrum* is easily recognised in the field.

The species pertaining to this association are:

- Gracelaria confervoides* (very common)
- Gracelaria armata* (common)
- Ceramium rubrum* (frequent)

Cladophoropsis Zollingeri (rare)
 Dilophus ligulatus (very rare)
 Polysiphonia phleborhiza (common)
 P. opaca (uncommon)
 Herposiphonia secunda (uncommon)
 Laurencia repillosa (fairly common)
 Cladophora sp. (rare)
 Rhodochorton sp. (common)
 Codium elongatum (very rare)

Occurrence: Sidi Bishr.

Dilophus ligulatus Association

The substratum, to which this association is attached, is formed of small shells of gastropods together with the shell debris and coarse sand and is generally inhabited by small crabs and worms. The *Dilophus* stolons ramify among this mixture and sometimes they reach the under-rocks to which they readily adhere.

This association is found all the year round in the upper sublittoral belt, and is characterised by the dominance of small microscopic forms most of which are epiphytes on the thallus of *Dilophus* itself.

Analysis of the association at the end of summer revealed the presence of the following species:

Melobesia farinosa (fairly common)
 Erythrocladia subintegra (uncommon)
 Ulva Lactuca (very rare)
 Cladophora sp. (common)
 Padina Pavonia (common)
 Chaetomorpha aerea (common)
 Ceramium Bertholdi (rare)
 Erythrotrichia reflexa (fairly common)
 Rhodochorton sp. (common)
 Jania rubens (rare)
 Caulerpa prolifera (frequent)
 Pterosiphonia pennata (fairly common)
 Halimeda Tuna (rare)

Occurrence: Sidi Bishr, Mandara, Abu Qir & Shatby.

Acanthophora Delilei Association

This association favours somewhat exposed localities with high temperature and intense light, though it is present in sheltered situations as well. It extends from the upper littoral to the upper sublittoral belt.

The association comprises the following species:

Laurencia paniculata (frequent)

Centroceras clavulatum (uncommon)
 Gelidium crinale (common)
 G. pusillum (common)
 Cladophora sp. (uncommon)
 Ulva Lactuca (frequent)
 Caulerpa prolifera (common)
 Melobesia farinosa (common)
 Bryopsis pennata (very rare)
 Hypnea musciformis (frequent)
 Cladophora pellucida (very rare)
 Chaetomorpha Linum (rare)
 Erythrocladia subintegra (frequent)
 Valonia utricularis (fairly common)
 Jania rubens (frequent)
 Cladophoropsis Zollingeri (fairly common)
 Spyridia aculeata (frequent)
 Laurencia obtusa (uncommon)
 Gymnogongrus Griffithsiae (very rare)
 Rhodochorton virgatulum (common)
 Corallina mediterranea (uncommon)
 Calothrix parasitica (uncommon)
 Lyngbya sp. (uncommon)
 Erythrotrichia sp. (uncommon)
 Ceramium gracillimum (rare)
 Halimeda Tuna (very rare)

Occurrence: Abu Qir.

Zostera marina Association
 (pl. III fig. 6)

This association favours muddy sand situations in the upper sublittoral belt, especially in places with polluted waters.

The association comprises the following epiphytes:

Cladophora sp. (very common)
 Rhodochorton sp. (frequent)
 Polysiphonia Gorgonia (uncommon)
 P. variegata (common)
 Goniotrichum (fairly common)
 Erythrocladia subintegra (fairly common)
 Ceramium tenuissimum (very rare)
 Hydroclathrus clathratus (rare)
 Ectocarpus sp. (frequent)
 Asterozystis ornata (frequent)
 Chondria sp. (fairly common)
 Hypnea musciformis (rare)
 Colpomenia sinuosa (rare)

together with some blue greens.

Periodic observations have shown that most of the species mentioned above are permanent components of the association with the exception of *Hydroclathrus* and *Colpomenia* which are present during winter and scarcely so in summer.

Occurrence: Kayet Bay & Abu Qir Bay.

VI. Summary

1. The topographical features of the investigated area revealed the presence of both sheltered and exposed situations, the streaming of fresh water from the Nile and brackish water from the lakes, and lastly the presence of different substrata with varying degrees of suitability for algal growth.

2. The general aspect of the flora through the different seasons of the year is discussed under the effect of the physical and chemical factors. The following conclusions are drawn out:

- a) The alternation of seasons has an effect on the algal profusion on the littoral belt. Abundance of algae seems to follow the increasing temperature curve with a maximum growth in spring when genera of the *Ceramiales* and specially of the *Rhodomelaceae* reach a high point of abundance on this belt.
- b) The wide range of temperature at Alexandria varying from 15 to 25° C throughout the year, has initiated the appearance of species of tropical affinities such as *Digenea simplex*, *Dasycladus claviformis* & *Anadyomene stellata*, as well as others of a cold-temperate affinity such as *Bangia fusco-purpurea* & *Nemalion helminthoides*.
- c) Certain species fluctuate during the seasons in a wide bathymetric range under the effect of temperature and light.
- d) Light affects also the growth form of certain individuals, and has a marked bleaching effect on the littoral algae particularly during summer. Certain species favour exclusively dim situations, e.g. *Cladophora pellucida*, *Udotea petiolata*, *U. minima*, *Rhodophyllis* & *Botryocladia*.
- e) Water currents help in the formation of new substrata on top of vegetation already existing in the following way: These currents bring sand and deposit it on the *Cystoseira* association inhabiting the rocky places at Sidi Bishr. *Caulerpa prolifera* not only establishes itself in this new sandy substratum but also helps in its formation and stabilisation; and thus paving the way for the more delicate forms such as *Pterosiphonia pennata*.
- f) Determinations of fluctuations in nutritive salts especially nitrates and phosphates are attempted for the first time on the Egyptian Mediterranean shores in the East Harbour. The result shows a maximum concentration in winter and a minimum in summer for both nitrates and phosphates.

tes. The abundance and scarcity of plankton generally correspond with those maxima and minima.

3. Epiphytism among algae based on observations of the species present in the district is studied; the following conclusions may be drawn out:

- a) Specialised and indifferent epiphytes are distinguished with regard to host.
 - b) Epiphytes may be dense in both exposed and sheltered localities.
 - c) Abundance of epiphytes occurs in summer when the stipes of most of the perennial forms such as *Laurencia* and *Cystoseira* become loaded with *Jania*, *Heterosiphonia*, and *Ceramium*. Those stipes deteriorate gradually till most of them are shed away during autumn.
4. Algal belts and algal formations are discussed with certain details of the associations. A brief illustrated picture of the vegetation inhabiting the littoral belts, tidal pools, isolated pools and crevices is given.
- a) Our sandy and muddy sand formation is characterised by the dominance of the *Caulerpa* association.
 - b) Algal associations in general are more or less overlapping, due to the narrowness of the littoral belt as a result of the small amplitude of tides.

VII. Acknowledgment

We wish to express our gratitude to Dr. M. A. Fikry Professor and Head of the Botany Department, for his unfailing help and criticism, and for the great facilities kindly placed at our disposal on every possible occasion.

We thank also S. Georgy and the other Staff of the Hydrobiological Station at Kayet Bay, where part of the work was carried out.

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Fig. 1

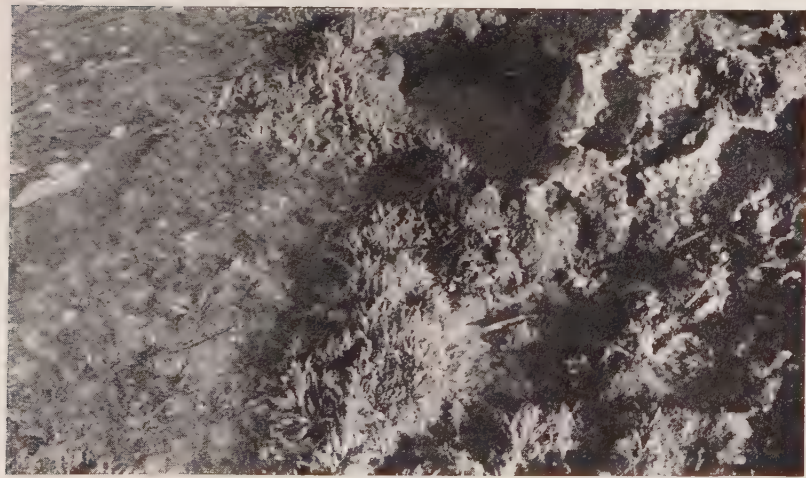


Fig. 2

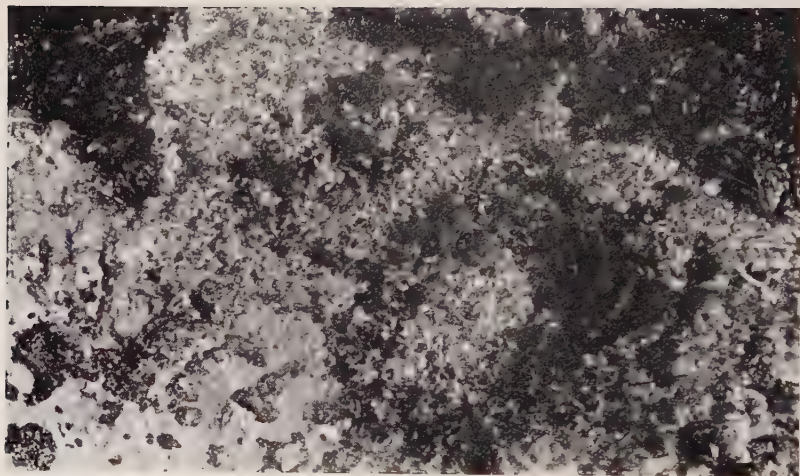


Fig. 3



Fig. 4

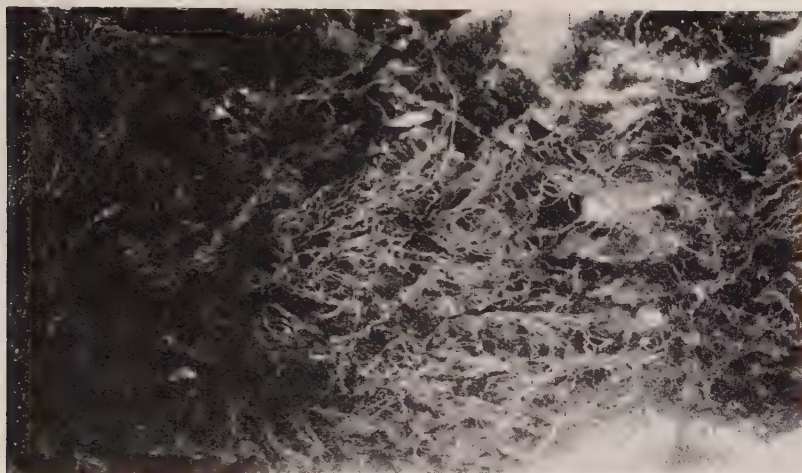


Fig. 5

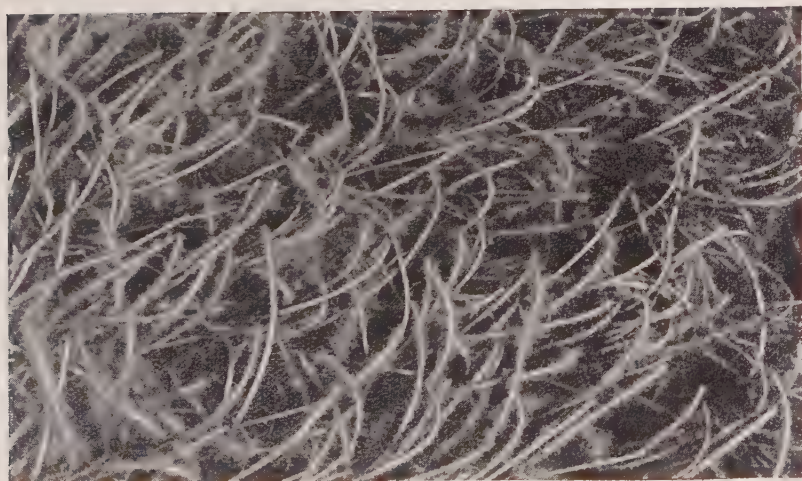


Fig. 6

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Nouvelles Données sur les Desmidiées des Environs de Matadi (Congo belge)

par

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I. Introduction

Dans une première étude sur les Desmidiées de Matadi, parue dans le 14e Biologisch Jaarboek, j'ai examiné les Desmidiées de trois échantillons que le Dr. W. BERVOETS a eu l'amabilité de m'envoyer. Après ce premier envoi, le Dr. BERVOETS a bien voulu continuer à récolter du matériel et m'a fait parvenir encore 4 échantillons dont le dernier ou 7e était un grand bocal parce qu'il avait remarqué lui-même une grande abondance d'algues et surtout de Desmidiées. Cet échantillon nous a donné de si importants résultats que nous avons jugé opportun de les traiter dans une étude à part. En effet nous y voyons comme une démonstration de nos conclusions générales faites antérieurement (1942 et 1947) en même temps qu'une preuve de plus qu'il est nécessaire de faire sur certains points des réserves parce que nos connaissances sur les Desmidiées du Congo sont encore trop éparses et que des conclusions prématurées ne peuvent qu'embrouiller le problème.

Aucun pays tropical ayant déjà fait l'objet de tant de recherches sur les Desmidiées (DE WILDEMAN, KUFFERATH, FRÉMY, VAN OYE à quatre reprises et EVENS) n'a donné des résultats si discordants.

D'autre part tous ces résultats, vus d'un point de vue spécial, c'est à dire en tenant compte de l'évolution du pays même et en même temps des circonstances écologiques, mènent à une conclusion générale propre au Congo (voir la fin de ce travail).

FRÉMY, mort à St. Malo lors de la libération de son pays, croyait que les grandes discordances dans les résultats obtenus par les différents auteurs devaient être imputées aux auteurs de ces différents travaux. J'ai démontré que ce savant se trompait et qu'au contraire ces différences très marquées étaient les conséquences de la grande diversité des différents biotopes examinés en rapport avec l'âge relativement jeune des flores Desmidiennes des parties du Congo dont on a récolté du matériel jusqu'à présent.

Il est évident que la flore Desmidienne d'un pays d'une superficie de plus de 80 fois la Belgique ne peut être connue par

l'examen d'un nombre restreint d'échantillons récoltés un peu au hasard et dans des contrées et des biotopes n'ayant souvent aucun rapport entre eux.

Néanmoins les différences ne sont pas purement d'ordre qualitatif et quantitatif, mais aussi peut-on remarquer que les différents échantillons présentent un faciès tout différent et très souvent voyons nous qu'une espèce est très abondante dans une contrée et complètement absente dans une autre où une autre espèce du même genre prédomine.

Il s'en suit que très souvent on a l'impression que dans les différentes contrées les espèces sont remplacées par d'autres du même genre. Mais ceci n'est qu'une façon de s'exprimer; le fait est que du même genre les espèces se rencontrent dans des contrées très différentes et très souvent on ne rencontre qu'une ou deux espèces du même genre à l'exclusion de toutes les autres du même genre qu'on rencontre à leur tour dans d'autres contrées dans les mêmes conditions que les premières.

Que FREMY après un examen minutieux du matériel qu'il avait à sa disposition ait été frappé par ces faits et ne se fiant qu'à ses propres résultats, en ait donné une explication fautive, est assez logique, mais il serait arrivé aux mêmes résultats que nous s'il avait eu autant de confiance dans les déterminations de ses collègues que dans les siennes.

D'autre part il faut reconnaître que les faits d'une importance biologique aussi grande comme je le démontre à la fin de ce travail, n'auraient probablement pas attiré mon attention sans la remarque erronée de FRÉMY.

Le Congo belge est le seul pays que je connaisse où la flore Desmidiennne présente ce caractère si typique.

L'échantillon dont j'ai examiné le contenu quant aux Desmidiées porte le N° 7 dans la série des échantillons que j'ai reçus du Dr. BERVOETS. Il a été récolté le 15 juin 1947 dans les conditions suivantes: marais peu profond situé sur la route Seke-Banza à environ 60 Km N.N.E. de Matadi, non loin de l'endroit où l'échantillon du 16.3.1947 avait été prélevé. Saison sèche, endroit sans ombre. Température eau 28° à 11 heures du matin.

Ces données ne nous donnent malheureusement pas de détails sur le chimisme de l'eau parce que les circonstances et le manque des appareils nécessaires ne permettaient pas au Dr. BERVOETS de les examiner, mais aussi longtemps qu'il ne sera pas possible d'examiner sur place, dans de bonnes conditions les biotopes nous devons nous en tenir à l'examen d'échantillons bien pris et dans des conditions assez précises pour nous permettre d'en tirer des conclusions générales fondées.

Je remercie bien cordialement le Dr. BERVOETS qui s'est donné tant de peine pour me procurer du matériel avec toutes les données possibles et dans les meilleures conditions que les circonstances lui permettaient.

II. Espèces trouvées

Genre *Cylindrocystis*

- 1° *Cylindrocystis Brebissonii* MENEGHINI
- 2° ——— var. *minor* W. & G. S. WEST
- N. 3° ——— *crassa* de BARY

Genre *Closterium*

- 1° *Closterium acerosum* (SCHRANK) EHRENBERG
- 2° ——— *cornu* EHRENBERG
- N. 3° ——— *costatum* CORDA var. *Westii* (CUSHMAN)
- N. 4° ——— *juncidum* RALFS
- 5° ——— *libellula* FOCKE var. *intermedium* (ROY & BISSETT) G.S. WEST
- N. 6° ——— *Ralfsii* de BREBISSON var. *hybridum* RABENHORST
- 7° ——— *setaceum* EHRENBERG

Genre *Pleurotaenium*

- N. 1° *Pleurotaenium congolense* n.sp.
- 2° ——— *trabecula* (EHRENBERG) NAEGELI
- 3° ——— var. *crassum* WITTRÖCK

Genre *Euastrum*

- N. 1° *Euastrum minutum* n.sp.
- N. 2° ——— *pseudopectinatum* SCHMIDLE
- 3° ——— *securiformiceps* BORGE

Genre *Cosmarium*

- N. 1° *Cosmarium Botrytis* MENEGHINI
- 2° ——— *circulare* REINSCH
- N. 3° ——— *connatum* de BREBISSON
- 4° ——— *cucurbita* de BREBISSON
- N. 5° ——— *pseudopyramidatum* LUNDELL var. *glabra* n. var.

Genre *Micrasterias*

- N. 1° *Micrasterias apiculata* (EHRENBERG) MENEGHINI var. *Evensi* n. var.

Genre *Staurastrum*

- N. 1° *Staurastrum polytrichum* (PERTY) RABENHORST

Genre *Hyalotheca*

- 1- *Hyalotheca dissiliens* (SMITH) de BREBISSON

Genre *Desmidium*

- N. 1° *Desmidium Swartzii* AGARDH var. *amblyodon* (ITZIGSOHN) RABENHORST

III. Observations concernant les espèces

Genre *Cylindrocystis*

Du genre *Cylindrocystis* il n'y a que l'espèce *Brebissonii* MENEHINI et sa variété *minor* W. & G. S. WEST qui ont été trouvées au Congo Belge.

Dans le matériel rapporté par LEBRUN j'ai retrouvé ces deux formes.

Il est très étonnant que ces deux formes se retrouvent aux environs de Matadi: une troisième, la *C. crassa* de BARY, fut également trouvée dans l'échantillon. Elle est nouvelle pour le Congo belge.

1° *Cylindrocystis Brebissonii* MENEHINI (Fig. 1)

Mensurations: Longueur 30 μ , largeur 15 μ , L./l. 2.

Le Dr. BEROETS n'a malheureusement pas eu l'occasion de prendre le pH du milieu dont il a pris l'échantillon en question. Il est à remarquer que parmi les espèces de Desmidiées rencontrées il y en a plusieurs qui sont connues des milieux franchement acides.

Comme nous n'avons cependant aucune donnée exacte concernant le pH de l'eau dont provient l'échantillon examiné, nous ne pouvons rien conclure. Il faut néanmoins faire observer que les dimensions sont à la limite inférieure des dimensions données par KRIEGER ce qui peut être considéré comme un indice que le milieu n'est pas optimal pour cette espèce. D'autre part le nombre d'exemplaires rencontrés était très minime, j'ai observé en tout 2 exemplaires de cette espèce.

2° *Cylindrocystis Brebissonii* MENEHINI var. *minor* W. & G. S. WEST (Fig. 2).

Mensurations: Longueur 27.5 μ , largeur 11 μ , L./l. 2.5

30 μ	11 μ	2.7
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30 μ	11 μ	2.5
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Les exemplaires de la variété *minor* W. & G. S. WEST trouvés dans le matériel examiné étaient tous, quant à leurs dimensions, très près de la limite supérieure donnée par KRIEGER; ils pourraient même être considérés comme appartenant à l'espèce. Il faut cependant remarquer que la variété est plus svelte que l'espèce. Ceci est surtout visible sur le vif, mais trouve son expression objective dans la relation de la longueur à la largeur. Chez l'espèce la relation L./l. est de 2 ou moins, chez la variété cette relation est toujours plus grande que 2, dans nos exemplaires elle était de 2.5 à 2.7.

J'ai remarqué à différentes reprises et pour tous les cas que j'ai examinés à ce sujet que la relation L./l. est un caractère qui très souvent peut être considéré comme spécifique. Je n'hésite

Nos exemplaires diffèrent de l'espèce par plusieurs points. Ils ne correspondent cependant pas exactement non plus avec la variété *Westii* à laquelle je les rapporte. Les exemplaires trouvés ont des caractères de la var. *subcostatum* (NORDSTEDT) KRIEGER, mais se rapprochent surtout de la variété *Westii* CUSHMAN. Je n'hésite pas à les considérer comme appartenant à cette variété les différences étant trop minimes pour en faire une nouvelle variété.

J'ai trouvé en 1943 dans le matériel de **LEBRUN** l'espèce même, les dimensions longueur 201 et 250 μ et largeur 25 et 30 μ , extrémités 10 sont abérrantes de celles que nous avons observées dans le matériel du Dr. **BERVOETS** provenant de Matadi.

On pourrait à la rigueur considérer en ce qui concerne les dimensions les exemplaires trouvés comme appartenant à l'espèce mais il y a surtout le facies général, la présence bien nette de ligne de suture (Gürtelband) qui me font considérer les exemplaires trouvés comme appartenant à la variété *Westii* CUSHMAN. Les stries sont très prononcées, peu nombreuses et à direction plus ou moins spiralée.

Cette variété est nouvelle pour notre colonie.

4° *Closterium juncidum* RALFS (Fig. 7)

Mensurations: Longueur 112 μ , largeur 3.5 μ , L./l. 32.
126 μ 3.6 μ 36.

Cette espèce est assez fréquente dans l'échantillon examiné. Elle est nouvelle pour le Congo Belge; en 1943 j'avais rencontré la variété *brevior* ROY dans le matériel de LEBRUN. L'espèce ressemble beaucoup à *Cl. gracile* de BREBISSE dont elle se distingue par la présence de stries sur la membrane.

5° *Closterium libellula* FOCKE var. *intermedium* (ROY & BISSETT)

G. S. WEST (Fig. 8)

Mensurations: Longueur 162 μ , largeur 26 μ , extr. 12 μ , L./l. 6,2.
121 μ 23 μ 10 μ 5,2.

Comme KRIEGER (RABENHORST p. 255) le fait remarquer cette variété est difficile à séparer de l'espèce. Seules les dimensions plus petites l'en distinguent. D'après Irénée MARIE, la taille de la variété serait à peine la moitié de celle du type!

L'espèce a été rencontrée au Congo par van OYE 1927. Les exemplaires de cette variété étaient assez nombreux dans le matériel examiné.

La variété *intermedium* (ROY & BISSETT) G. S. WEST est tout aussi répandue que l'espèce. On peut dire que c'est une espèce cosmopolite.

Elle semble assez commune aux environs de Matadi, je l'avais

déjà rencontrée antérieurement dans du matériel du Dr. BERVÖETS (Biol. Jaarb. 1947, 14, p. 147).

6° *Closterium Ralfsii* de BREBISSEON var. *hybridum* RABENHORST (fig. 9)

Mensurations: Longueur 402 μ , largeur 35 μ , extr. 10 μ , L./l. 14,4.

Membrane brune à fines stries avec ligne de suture nette, elle se distingue de l'espèce par sa largeur beaucoup moindre.

Espèce nouvelle pour le Congo Belge.

Nos exemplaires correspondent en tous points avec la description.

Alors que cette variété est nouvelle pour le Congo Belge elle était déjà connue de l'Afrique Orientale et du Cap, sa présence au Congo n'offre donc rien d'étonnant.

7° *Closterium setaceum* EHRENBURG (fig. 10)

Mensurations: Longueur 490 μ , largeur 15 μ , extr. , L./l. 32,6.
245 μ 10 μ 3 μ 24,5.

Espèce rencontrée pour la première fois au Congo Belge aux environs de Matadi dans du matériel du Dr. BERVÖETS (van OYE Biol. Jaarb. 1497, 14, 147). Comme je l'ai fait remarquer à cette occasion j'ai trouvé les trois espèces du même groupe *Cl. Kützingerii*, *Cl. rostratum* et *Cl. setaceum* dans un même échantillon. Dans le matériel examiné ici je n'ai trouvé que l'espèce *Cl. setaceum* mais en plusieurs exemplaires.

Elle est connue en ce qui concerne les pays tropicaux entre autres de Ceylan, de Sumatra et de Madagascar.

Genre *Pleurotaenium*

Le genre *Pleurotaenium* est assez rare au Congo belge. Seulement 8 espèces étaient connues jusqu'en 1947 de notre colonie.

Dans l'échantillon examiné j'ai rencontré 3 espèces dont une nouvelle pour la science. Je l'ai déjà mentionnée mais non décrite dans mon travail concernant les 3 premiers échantillons envoyés par le Dr. BERVÖETS. J'en donne ici une description complète. D'autre part j'ai trouvé encore une *Pl. trabecula* (EHRENBURG) NAEGELI var. *crassum* WITTRÖCK citée pour la première fois par van OYE en 1943.

Avec les nouvelles espèces pour le Congo Belge citées dans mon étude de 1947 le nombre d'espèces de *Pleurotaenium* connues jusqu'à ce jour de notre colonie s'élève maintenant à 12.

C'est avec le genre *Micrasterias* un des genres qui montrent le plus nettement une distribution particulière permettant notre conclusion générale sur la répartition des Desmidiées au Congo belge.

Ce genre se trouve dans presque toutes les eaux à l'exception des eaux très polluées. Cependant on ne connaît aucune espèce réellement planctonique. D'après KRIEGER (RABENHORST, Kryptogamen Flora) il y a des formes qui ne se rencontrent que dans les pays tropicaux.

Je crois qu'une étude plus approfondie de ce genre nous montrera une distribution géographique très typique. Au Congo belge nous avons des espèces qui sont dispersées sur tout le territoire tandis que d'autres se rencontrent à l'est et à l'ouest, mais n'ont pas encore été trouvées dans le centre de notre colonie. Tous ces points demandent encore une vérification et ne peuvent être discutés ici.

1° *Pleurotaenium congolense* n. sp. (fig. 11, 12, 13)

Mensurations:

Longueur	560 μ	largeur	145 μ	isthme	85 μ	extr.	40 μ	L./l.	3,8
	560 μ		148 μ		90 μ		45 μ		3,7
	550 μ		130 μ		90 μ		41 μ		4,2
	550 μ		146 μ		85 μ		48 μ		3,8
	560 μ		128 μ		90 μ		45 μ		4,3
	610 μ		140 μ		90 μ		44 μ		4,3
	530 μ		126 μ		73 μ		45 μ		4,2
	422 μ		126 μ		90 μ		40 μ		3,3
	410 μ		120 μ		90 μ		40 μ		3,4
	480 μ		135 μ		85 μ		35 μ		3,5
	560 μ		150 μ		75 μ		45 μ		3,7
	502 μ		138 μ		80 μ		45 μ		3,5
	495 μ		130 μ		80 μ		40 μ		3,8
	552 μ		140 μ		75 μ		45 μ		4
	510 μ		140 μ		70 μ		45 μ		3,6
	520 μ		140 μ		75 μ		40 μ		3,7
	540 μ		130 μ		70 μ		40 μ		4,1
	510 μ		130 μ		70 μ		40 μ		4,1
	563 μ		135 μ		85 μ		40 μ		4,1
	540 μ		130 μ		90 μ		40 μ		4,1
	520 μ		130 μ		75 μ		43 μ		4
	485 μ		140 μ		82 μ		35 μ		3,4

A première vue on peut voir qu'on a à faire à une espèce de *Pleurotaenium* appartenant au groupe de *Pl. truncatum* (de BRE-BISSON) NAEGELI et *Pl. ovatum* NORDSTEDT.

Voyons d'abord quels sont les caractères distinctifs de ces 2 espèces.

Pl. truncatum

Longueur	230—762 μ
Largeur	40—75 μ
Extrémité	24—42 μ
L./l.	6—9

Pl. ovatum

Longueur	260—421 μ
Largeur	61—121 μ
Extrémité	32—39 μ
L./l.	3—4

Semisomates à large base pouvant présenter une ondulation puis s'élargissant, à cotés convexes, tronqués, de forme fusiforme allongée, étirée d'un coté.

Extrémité terminale à coins arrondis et présentant au milieu une couronne de verrues parfois difficiles à observer.

Membrane plus ou moins nettement poreuse.
Sans vacuoles terminales.

Semisomates s'élargissant directement à partir de l'isthme, sans ondulation à cotés parallèles d'abord puis se rétrécissant, tronqués, pyriformes.

Extrémité terminale à coins arrondis et présentant au milieu une couronne de perles bien visibles.

Membrane finement poreuse.

Vacuoles terminales à cristaux.

A part ces deux espèces KUFFERATH a décrit en 1932 une troisième espèce *Pleurotaenium inflatum* KUFFERATH, à dimensions: longueur 345—470 μ , largeur 115—160 μ , isthme 104—108 μ , extrémité 32—40 μ ; membrane à ponctuations disséminées qui se rapproche de *Pl. truncatum*. Sans examiner ici la valeur systématique de cette nouvelle espèce de KUFFERATH, que KRIEGER considère comme *Pl. ovatum* var. *tumidum* (MASKELL) G. S. WEST, il est certain que déjà les dimensions et la forme, reproduite par les dessins 5 et 6 de KUFFERATH, nous permettent d'affirmer que cet auteur n'a pas eu sous les yeux des exemplaires qui puissent être comparés avec les nôtres.

Nous pouvons donc nous en tenir pour notre étude aux 2 espèces reconnues comme telles par les desmidiologues.

D'autre part dans leur étude sur les algues d'eau douce et subaériennes du Natal FRITSCH et RICH donnent la description d'une nouvelle forme de *Pleurotaenium ovatum* qu'ils distinguent sous le nom de forma *angustior*.

A première vue le dessin que donnent ces auteurs pourrait faire naître l'idée que nous avons à faire à une forme correspondant à notre *Pl. congolense*.

Déjà KRIEGER a considéré la forme *angustior* de FRITSCH et RICH comme synonyme de *Pleurotaenium truncatum* (de BREBISON) NAEGELI var. *crassum* BOLDT et je crois que cet auteur a raison, mais et la figure et surtout les dimensions que donnent FRITSCH et RICH notamment la longueur des cellules 305—405 μ , largeur 78—81 μ , extrémité 33 μ , prouvent que *Pl. ovatum* NORDSTEDT forma *angustior* FRITSCH et RICH ne peut être considérée comme synonyme de *Pleurotaenium congolense* n. sp.

Nous voyons en comparant nos dessins faits sur les objets projetés que les dimensions diffèrent et avec *ovatum* et avec *truncatum*; mais pour ne pas allonger cette étude, nous voulons dresser un tableau comparatif.

	<i>Pl. truncatum</i>	<i>Pl. congolense</i>	<i>Pl. ovatum</i>
Longueur	230—762 μ	410—610 μ	260—421 μ
Largeur	40—75 μ	120—150 μ	61—121 μ
Extr.	24—42 μ	35—48 μ	32—39 μ
L./l.	6—9	3,1—4,3	3—4

Semistomate s'élargissant directement sans ondulation à la base. A cotés parallèles se rétrécissant à l'extrémité tronquée, cylindriques terminés en cônes tronqués. Extrémité terminale à coins arrondis et présentant au milieu une série de perles peu visibles. Membrane finement poreuse sans vacuoles terminales.

Un examen du tableau comparatif nous montre à première vue déjà une série de caractères qui placent le *Pl. congolense* entre *truncatum* et *ovatum* à tel point que j'ai été sur le point d'exprimer cette place intermédiaire dans le nom spécifique. Cependant le facies général, la présence très nette d'une ceinture d'un brun bien prononcé m'ont amené à séparer complètement la nouvelle espèce des 2 autres déjà décrites.

La nouvelle espèce se rencontre en grande quantité dans l'échantillon 7 du Dr. Bervoets mais se rencontre aussi dans d'autres échantillons des environs de Matadi également récoltés par le Dr. Bervoets.

La forme est absolument typique et se distingue nettement de toutes celles des espèces décrites de ce groupe.

Diagnose:

Grande espèce de *Pleurotaenium*, fusiforme allongée, à extrémités amincies et tronquées. Rétrécie au milieu par une ceinture brune très distincte (voir figure). Semisomates sans gonflement ni ondulation à la base, s'élargissant directement à partir de la ceinture, à cotés parallèles ou presque, se rapprochant légèrement à l'extrémité qui est tronquée, coté terminal parallèle à l'axe transversale, présentant une série de 6 à 8 perles difficilement visibles, parfois la paroi des angles terminaux est épaissie et peut même donner par exception des pointes arrondies.

Longueur totale 410—610 μ , largeur 120—150 μ , extrémité 35—48 μ , L./l. 3—4,5.

Habitat eau marécageuse, environs de Matadi, Congo belge.

A part le cas de *Pleurotaenium inflatum* Kufferath qui doit être considéré d'après Krieger comme synonyme de *Pl. ovatum* Nordstedt var. *tumidum* (Maskell) G. S. West, c'est la première fois qu'une espèce de *Pleurotaenium* du groupe *truncatum* *ovatum* a été trouvée au Congo Belge.

Nous avons donc comme représentants de ce groupe: *Pl. ovatum* NORDSTEDT var. *tumidum* (MASKELL) G. S. WEST trouvé par KUFFERATH et *Pl. congolense* n.sp. trouvé aux environs de Matadi.

Il est à remarquer que Kiluama (Ndembo) se trouve près de Kisantu dans le Bas-Congo. Les deux formes de ce groupe trouvées au Congo belge se rencontrent donc dans l'ouest de notre colonie.

2° *Pleurotaenium trabecula* (EHRENBERG) NAEGELI
(fig. 14, 15)

Mensurations:

Longueur 450 μ ,	largeur 45 μ ,	extr. 25 μ ,	L./l. 10.
466 μ	42 μ	26 μ	11.

Les exemplaires rencontrés dans le matériel du Dr. BEROETS correspondent en tous points à l'espèce typique qui a déjà été trouvée au Congo belge par l'abbé FRÉMY (1932—33) et par van OYE (1943).

Pour les détails je renvoie à ma publication sur les Desmidiées du Parc National Albert, Mission J. LEBRUN, p. 20.

Cette espèce est très voisine de *Pleurotaenium Ehrenbergii* (de BREISSON) de BARY qui a été trouvée au Congo belge par FRÉMY (1932—33) et van OYE (1927).

3° *Pleurotaenium trabecula* (EHRENBERG) NAEGELI
var. *crassum* WITTRICK (fig. 16).

Mensurations: Longueur 260 μ , largeur 36 μ , isthme 28 μ , extr. 18 μ , L./l. 7,2.

La variété *crassum* de *Pl. trabecula* a déjà été mentionnée pour le Congo belge par van OYE en 1943.

Je n'ai rien à ajouter aux remarques faites à ce moment concernant cette espèce, je renvoie le lecteur à cette publication (van OYE 1943, p. 20).

Genre *Euastrum*

Déjà 16 espèces de ce genre sont connues du Congo belge. Nous avons rencontré 3 espèces dans le matériel examiné. Une *E. securiformiceps* BORGE a déjà été trouvée au Congo (van OYE 1943). Les deux autres formes sont nouvelles pour la science.

1° *Euastrum minutum* n.sp. (fig. 17)

Mensurations:

Longueur 22.5 μ ,	largeur 14 μ ,	isthme 5 μ ,	L./l. 1,6.
22.5 μ	15 μ	7.5 μ	1,5.

Cette nouvelle espèce qui pourrait être confondue avec un *Cos-*

marium, s'en distingue par l'échancrure du lobe frontal toujours bien visible dès qu'on y prête l'attention.

Elle possède 2 pyrénoides, un dans chaque hémisomate et bien central.

Membrane lisse.

Lobes latéraux bien distincts du lobe central mais fort peu entre eux à angles arrondis. Sinus linéaire très profond, dépassant le $\frac{1}{4}$ de la largeur de façon que l'isthme est très étroit et ne dépasse jamais la $\frac{1}{2}$ de la largeur, il peut même atteindre à peine le $\frac{1}{3}$ de la largeur.

Diagnose :

Petite espèce d'*Euastrum* d'une longueur totale d'environ 22.5 μ , $1\frac{1}{2}$ fois plus longue que large. Un pyrénotide central dans chaque hémisomate. Membrane lisse. Lobes latéraux à angles arrondis. Sinus linéaire. Isthme très étroit.

2° *Euastrum pseudopectinatum* SCHMIDLE

Mensurations :

Longueur	52.5 μ ,	largeur	40 μ ,	isthme	8 μ ,	L./l.	1,31.
	46 μ		35 μ		6 μ		1,31.
	48 μ		38 μ		6 μ		1,26.

Largeur du lobe médian 21 μ .

Cette espèce d'*Euastrum* a été décrite par SCHMIDLE sur du matériel provenant de l'île de Zanzibar récolté par STUHLMANN dans une source, puis décrite comme variété *evolutum* d'un méandre à courant lent du fleuve Nyassa et enfin elle a été trouvée par G. S. WEST dans du matériel provenant du Tanganyika.

SCHMIDLE a cru devoir décrire une variété et G. S. WEST une forme spéciale, moi-même j'ai hésité à faire une variété *occidentalis*, mais je crois qu'en comparant les descriptions de SCHMIDLE et G. S. WEST avec mes données il y a lieu de n'admettre que l'espèce *pseudopectinatum* de SCHMIDLE en admettant une plus grande variabilité que n'admettait l'auteur lors de sa première description.

Il est à remarquer que cette espèce se rencontre dans la partie orientale de l'Afrique ainsi que dans la partie occidentale. Elle est une des formes qui illustrent ma façon de considérer la flore Desmidiennne du Bas-Congo (voir Conclusions Générales).

3° *Euastrum securiformiceps* BERGE (fig. 18)

Mensurations :

Longueur	72 μ ,	largeur	40 μ ,	isthme	10 μ ,	L./l.	1,8.
	70 μ		37.5 μ		12.5 μ		1,8.
	71 μ		38 μ		12.5 μ		1,8.
							Lobe polaire 17.5 μ .

Dans mon étude du matériel de LEBRUN (Exploration du Parc National Albert, Mission LEBRUN, Desmidiées) j'ai dit que je ne pouvais pas suivre KRIEGER qui considère l'espèce *securiformiceps* BORGE comme une variété de *E. sinuosum* LENORMAND. D'autre part les dimensions ne correspondaient pas avec celles mentionnées par BORGE. Néanmoins je ne croyais pas devoir considérer ces exemplaires comme une nouvelle forme. Les exemplaires trouvés dans le matériel du Dr. BERVOETS viennent appuyer ma façon de voir. La forme est identique à celle des exemplaires trouvés dans le matériel de LEBRUN et celle décrite par BORGE et les dimensions correspondent en partie avec les données de BORGE et en partie avec les miennes de 1943.

La membrane de tous les exemplaires observés dans le matériel du Dr. BERVOETS était nettement glabre.

Nous voyons donc que pour l'espèce *E. securiformiceps* BORGE nous devons admettre comme dimensions :

Longueur 60—79 μ , largeur 28—40 μ , isthme 10—12.5 μ , L./l. 1,8—2,19, lobe polaire 17.5—20 μ .

Il faut aussi distinguer une variété *E. securiformiceps* BORGE var. *punctulatum* van OYE (Exploration Parc National Albert. Mission Lebrun Fasc. 8 p. 22) dont la membrane est nettement ponctuée et dont les dimensions sont en moyenne un peu plus grandes que celles de l'espèce, et notamment longueur 70—90 μ , largeur 30—38 μ , isthme 9—15 μ , lobe polaire 20—24 μ , L./l. 2,12—2,75.

Malgré que les extrêmes des mensurations chevauchent en partie les unes sur les autres, il est clair que la variété *punctulatum* est en moyenne plus grande que l'espèce et nous pouvons donc distinguer nettement cette variété de l'espèce. Par ailleurs la membrane présente une ponctuation très nette, ce qui n'est pas le cas pour l'espèce.

Genre *Cosmarium*

De ce genre, qui est rare au Congo belge, nous avons trouvé 5 espèces dans l'échantillon N° 7 du Dr. BERVOETS. Trois de ces espèces sont nouvelles pour notre colonie. Les espèces trouvées sont :

N. *Cosmarium Botrytis* MENEGHINI.

Cosmarium circulare REINSCH.

N. *Cosmarium connatum* de BREBISSON.

Cosmarium cucurbita de BREBISSON.

N. *Cosmarium pseudopyramidatum* LUNDELL var. *glabra* n.var.

1° *Cosmarium Botrytis* MENEGHINI

Mensurations : Longueur 75 μ , largeur 66 μ , isthme 30 μ , L./l. 1,1.

Espèce nouvelle pour le Congo.

Elle est une des espèces du genre *Cosmarium* des plus communes de toute l'Europe et se rencontre dans les biotopes les plus variés. Aussi bien l'espèce que les variétés semblent rares dans les pays tropicaux, mais il n'est pas encore possible de dire si cette espèce présente une distribution géographique déterminée ou bien si sa distribution dépend uniquement des circonstances écologiques.

2° *Cosmarium circulare* REINSCH (fig. 19)

Mensurations: Longueur 48 μ , largeur 40 μ , isthme 20 μ , L./l. 1,2.

Cosmarium circulare REINSCH a déjà été trouvé par van OYE dans le matériel de LEBRUN. Les mensurations sont un peu moindres que les dimensions données par W. et G. S. WEST mais il me semble que cette petite différence ne justifie pas la création d'une nouvelle espèce.

Espèce rare au Congo belge. Je l'avais déjà rencontrée dans les 3 premiers échantillons récoltés par le Dr. BEROETS aux environs de Matadi.

3° *Cosmarium connatum* de BREBISSON (fig. 20)

Mensurations:

Longueur 67.5 μ , largeur 50 μ , isthme 48 μ , L./l. 1,37.

Cette espèce trouvée pour la première fois au Congo belge dans le matériel du Dr. BEROETS qui a fait l'objet de ma première étude se rencontre en assez grand nombre dans l'échantillon N° 7. Cette espèce est connue de l'Afrique Centrale, de Sumatra, de Java, du Brésil et du Canada. D'autre part elle a été trouvée dans la plupart des pays d'Europe; néanmoins sa dispersion n'est pas encore élucidée.

Elle semble cosmopolite mais nullement ubiquiste.

4° *Cosmarium cucurbita* de BREBISSON (fig. 21)

Mensurations: Longueur 32 μ , largeur 18 μ , isthme 16 μ , L./l. 1,7.

Au sujet de cette espèce en rapport avec sa dispersion au Congo belge il est difficile de se faire une idée exacte, car il est fort probable que des confusions se soient produites entre *Cosmarium* (*Penium*) *cucurbitum* BISSET et *Cosmarium cucurbita* de BREBISSON, quoique les dimensions soient différentes. Si nous nous en tenons à notre colonie, il est certain que nous avons trouvé *Cosmarium cucurbita* de BREBISSON le 7 avril 1926 dans un étang artificiel à Stanleyville et que nous avons trouvé *Cosmarium cucurbitum* BISSETT dans le matériel de LEBRUN provenant du marais de Kikeri au pied du volcan Mikenô au nord du lac Kivu à une altitude de 2,226 m le 16 septembre 1937 à un pH de 4.8.

L'espèce *C. cucurbita* de BREBISSON a donc été trouvée jusqu'à présent au Congo Belge à Stanleyville et aux environs de Matadi.

5° *Cosmarium pseudopyramidatum* LUNDELL
var. *glabra* n.var. (fig. 22, 23, 24)

Mensurations:

Longueur	58 μ	largeur	35 μ	isthme	9 μ	L./l.	1,6.
	52 μ		34 μ		7,5 μ		1,5.
	55 μ		33 μ		10 μ		1,5.
	58 μ		35 μ		11 μ		1,6.
	56 μ		34 μ		11 μ		1,6.

Tout comme KRIEGER nous avons trouvé des exemplaires du *C. pseudopyramidatum* qui présentaient des dimensions un peu plus grandes que celles de la forme type décrite par BERGE et provenant du Brésil. En ce qui concerne les dimensions nos exemplaires sont comparables à celles décrites par KRIEGER (1932 p. 183), seul l'isthme qui mesurait 15 μ chez les exemplaires de KRIEGER ne mesurait que 7.1 μ à 11 μ chez les nôtres.

D'autre part la membrane de tous nos exemplaires était absolument glabre.

Ce dernier caractère me porte à considérer les formes trouvées comme appartenant à une variété nouvelle que j'appelle var. *glabra*.

Diagnose:

Variété se distinguant de l'espèce par sa membrane glabre, sa longueur plus grande, sa largeur dépassant légèrement le maximum de la largeur de l'espèce.

Genre *Staurastrum*

Le genre *Staurastrum* est représenté au Congo belge par 12 espèces.

Aux environs de Matadi nous n'avons trouvé dans l'échantillon N° 7 du Dr. BERVOETS qu'une espèce.

Staurastrum polytrichum (PERTY) RABENHORST
(fig. 25)

Mensurations: Longueur 78—83 μ , largeur 52.5—58 μ , isthme 24 μ , L./l. 1,4.

Malgré le peu de différence entre les espèces de *Staurastrum polytrichum*, *Saxonicum* et *cumbricum* je crois avoir à faire à l'espèce *polytrichum*; dans tous les cas elle est nouvelle pour le Congo belge.

C'est une des belles espèces de *Staurastrum* relativement facile à identifier. Elle n'est mentionnée que de l'Inde (sans autre indication) comme pays tropical.

KRIEGER ne l'a pas trouvée dans le matériel de l'expédition limnologique aux îles de la Sonde.

Nellie CARTER la mentionne dans le volume V de la monogra-

phie de W. et G. S. WEST entre autres des Etats-Unis et du nord-ouest du Canada. Frère IRÉNÉE MARIE dans la Flore Desmidiæ de la Région de Montréal ne mentionne aucune des trois espèces très voisines. Nous devons en conclure que cette espèce qui semble très rare au Congo belge présente une dispersion géographique non explicable jusqu'à présent et différente de celle de la plupart des Desmidiées.

Genre *Micrasterias*

Le genre *Micrasterias* est représenté par 7 espèces et variétés au Congo belge.

A plusieurs reprises j'ai eu l'occasion de parler au sujet de la distribution très caractéristique des espèces de ce genre.

Déjà en 1926 une espèce de ce genre a attiré mon attention et depuis lors les faits sont venus s'accumuler.

Dans le matériel examiné de nouveau une seule espèce, mais cette fois très rare et un seul exemplaire seulement. A part cela absolument rien du genre *Micrasterias*.

Micrasterias apiculata (EHRENBERG) MENECHINI var. *Evensi* n.var.
(fig. 26)

Mensurations: Longueur 205 μ , largeur 155 μ , isthme 30 μ , lobe pol. 72 μ , longueur lobe pol. 45 μ , L./l. 1,3.

La nouvelle variété de *Micrasterias apiculata* se distingue de l'espèce type par plusieurs caractères.

Le sinus est d'abord fermé à peu près jusqu'au tiers en partant du centre de la cellule, puis la partie suivante est ouverte, donc à peu près sur $2/3$. Les incisures entre le lobe frontal et les lobes latéraux ainsi que celles entre les lobes latéraux sont profondes et largement ouvertes et pointues à la base. Les incisures entre les lobes du 2e et 3e ordre en pointe moins aigues que celle des incisures principales. Les épines du lobe frontal sont également différentes de ce qu'on observe chez l'espèce.

La var. *Evensi* présente un commencement de dédoublement des parties supérieures externes du lobe frontal; il n'y a pas de paire d'épines divergentes aux angles du lobe frontal ni d'épine courbée du côté sagittal. On trouve des épines le long de la marge plus ou moins concave du lobe frontal mais ces épines ne montrent aucune symétrie dans leur disposition. Les extrémités des lobes latéraux ne sont jamais réellement pointues mais tout au plus ou moins pointues.

Sur toute la membrane se trouvent des épines dispersées sans ordre.

Au milieu de la cellule il y a un espace glabre limité par un nombre restreint d'épines, mais toujours plus grand que quatre et disposées d'une façon irrégulière.

Les dimensions ne correspondent pas non plus avec celles de l'espèce type. C'est surtout dans la proportion entre la longueur et la largeur qu'on peut remarquer une différence notable.

Genre *Hyalotheca*

Les espèces du genre *Hyalotheca* ont déjà été trouvées au Congo belge à différentes reprises par FRÉMY en 1933 et van OYE en 1923 et 1926.

Il faut faire remarquer que les 2 espèces trouvées, *H. dissiliens* (SMITH) de BREBISSON et *H. mucosa* MERTENS se présentent toujours en un nombre très restreint d'exemplaires.

Il est à remarquer que jusqu'ici je n'ai trouvé des représentants du genre *Hyalotheca* que dans la partie occidentale du Congo.

Hyalotheca dissiliens (SMITH) de BREBISSON (fig. 27)

Mensurations: Longueur des cellules 12.5—15—13—14—16 μ , largeur 17.5—18 μ .

Cette espèce n'a été mentionnée jusqu'à présent que de la partie occidentale du Congo belge, comme je l'ai déjà dit; ceci est d'autant plus étonnant qu'elle est connue de Madagascar et de la colonie du Natal.

Il faut remarquer que tout en se trouvant dans plusieurs échantillons du Dr. BERVOETS provenant des environs de Matadi elle y est toujours très rare.

D'ailleurs comme je l'ai fait remarquer dans mon étude parue dans le Biologisch Jaarboek 1947, 14, les Desmidiées filamenteuses sont toujours rares au Congo et surtout dans la partie orientale où elles n'ont pas encore été observées jusqu'à présent.

Genre *Desmidium*

Du genre *Desmidium* 6 espèces et variétés sont connues du Congo belge. Toutes ont été trouvées dans la partie occidentale de notre colonie. DE WILDEMAN en 1889, FRÉMY en 1932—33 et van OYE en 1926—27 et 1947.

Desmidium Swartzii AGARDH var. *amblyodon* (ITZIGSOHN)

RABENHORST (fig. 28)

Mensurations: Longueur des cellules 20 μ , largeur 32 μ , L./l. 0,6.

Cette variété est nouvelle pour le Congo Belge.

L'espèce avait été trouvée par DE WILDEMAN et FRÉMY tandis que la variété *quadrangulatum* (RALFS) ROY a été mentionnée par van OYE 1927.

La variété *amblyodon* (ITZIGSOHN) RABENHORST n'était connue jusqu'à présent que d'Europe, Amérique du Nord et le Brésil.

IV. Conclusions generales

Dans un seul échantillon du matériel du Dr. Bervoets j'ai trouvé 25 espèces de Desmidiées, ce qui est énorme pour le Congo belge. En Europe des cas sont connus où un échantillon de matériel révéla la présence de plus de 100 espèces de Desmidiées et aux Indes orientales des chiffres de 50 à 75 et plus ne sont pas rares.

Au Congo belge le chiffre de 25 espèces, pour un échantillon est le maximum trouvé à ce jour.

Ceci illustre bien ma conclusion de 1942 et 1947 quand je dis que la flore Desmidiennne de notre colonie est pauvre en espèces, surtout si l'on la considère par biotope ou contrée.

Des 25 espèces 10 sont nouvelles pour notre colonie et de ces 10, il y en a 4 qui sont nouvelles pour la science, notamment *Pleurotaenium congolense*, *Euastrum minutum*, *Cosmarium pseudopyramidatum* var. *glabra* et *Micrasterias apiculata* var. *Evensi*.

Dans ma première note sur les Desmidiées des environs de Matadi (Biol. Jaarb. 1947, 14, 145—158) j'ai mentionné 24 espèces provenant de 3 échantillons et de ces 24 espèces 13 étaient nouvelles pour notre colonie.

En tenant compte du fait que plusieurs espèces étaient déjà mentionnées dans ma première note nous arrivons à un total de 33 espèces connues jusqu'à présent du Bas-Congo.

Ce chiffre vient encore une fois souligner mes conclusions de 1942 et 1947.

Il faut remarquer la présence de *Staurastrum polytrichum* et celle de *Micrasterias apiculata* var. *Evensi* ainsi que celle de trois espèces d'*Euastrum*.

Dans le matériel de ma première note je n'ai rencontré aucune espèce des genres *Euastrum* et *Staurastrum* et j'ai même attiré l'attention sur l'absence totale à ce moment d'espèces du genre *Euastrum* dont on connaît déjà 16 espèces du Congo et du genre *Staurastrum* dont le nombre d'espèces connues de notre colonie s'élève à 11.

Du genre *Desmidium* dont 6 espèces et variétés sont connues du Congo belge, je n'ai pas retrouvé l'espèce *gracileps* trouvée auparavant, mais bien la variété *amblyodon* (ITZIGSOHN) RABENHORST de l'espèce *Swartzii* AGARDH. Ceci porte le nombre d'espèces et de variétés de ce genre connues du Congo belge à 12.

Enfin il faut remarquer qu'au nombre déjà relativement grand de Desmidiées connues de l'Afrique orientale et retrouvées aux environs de Matadi s'ajoutent encore plusieurs nouvelles entre autres *Euastrum securiformiceps*.

Quoique le nombre d'auteurs qui se sont occupés de l'étude des algues du Congo belge, et surtout des Desmidiées soit très petit: DE WILDEMAN, KUFFERATH, FREMY, van OYE et Fr. EVENS (travail sous presse dans la Revue Zoologique et Botanique Africaine) on

peut cependant tirer des conclusions générales de leur travaux.

Dans ce cas il faut surtout tenir compte du fait que van OYE a eu l'occasion de faire des recherches sur place et qu'il a pu examiner du matériel de différentes contrées très éloignées les unes des autres.

Que Fr. EVENS qui a débuté et travaillé pendant des années dans mon laboratoire a été prié d'examiner le matériel de mes différentes études sans qu'il puisse se rendre compte du but poursuivi est arrivé néanmoins au même résultat.

Enfin il faut se rappeler que FRÉMY, qui n'était pas spécialisé dans l'étude des Desmidiées, arrive également à des résultats tout à fait en opposition avec ceux des autres auteurs. Ce qui n'a rien d'étonnant si l'on admet l'explication que j'ai donnée de tous les faits connus jusqu'en 1942. D'autre part les résultats de FRÉMY ainsi que ceux des différents autres auteurs sont inexplicables si l'on admet pas cette façon de voir.

En tenant compte de ce qui précède nous voyons que quoique DE WILDEMAN (1889), van OYE (1925, 1926, 1927a et b, 1942, 1943, 1947), KUFFERATH (1932), FREMY (1932, 1933) et EVENS (sous presse) ont eu à leur disposition du matériel de provenance très diverse et deux de ces auteurs EVENS et van OYE ont disposé de grandes quantités d'échantillons, aucun ne peut parler d'une grande richesse en Desmidiées du Congo.

Une comparaison directe avec la richesse en Desmidiées est possible à van OYE qui a passé sept ans en Indonésie où il a examiné sur place les microorganismes des milieux les plus variés.

Nous devons donc admettre comme un fait acquis que l'Afrique centrale est relativement pauvre en espèces de Desmidiées.

Nous voyons ensuite que chaque auteur tout en ne trouvant qu'une très petite quantité de Desmidiées trouve toujours une quantité relativement très grande de nouvelles espèces pour notre colonie.

Ceci est d'autant plus frappant quand on réfléchit au fait que van OYE a déjà étudié du matériel de différentes contrées et arrive jusqu'à présent toujours à des résultats concordant sous ce rapport. Les chiffres suivants illustrent ces faits:

1889 DE WILDEMAN 12 espèces (naturellement toutes nouvelles pour le Congo)

1923-27 van OYE 39 espèces dont 35 nouvelles pour le Congo

1932 KUFFERATH 9 espèces dont 6 nouvelles pour le Congo

1932 FREMY 36 espèces dont 31 nouvelles pour le Congo

1943 van OYE 45 espèces dont 42 nouvelles pour le Congo

1947 van OYE 26 espèces dont 11 nouvelles pour le Congo

van OYE la présente étude 25 espèces dont 10 nouvelles pour le Congo

EVENS 38 espèces dont 21 nouvelles pour le Congo

Nous voyons à côté de la conclusion déjà émise aussi que le

nombre relatif des nouvelles espèces pour le Congo diminue régulièrement ce qui est naturel, mais est une preuve de plus pour notre conclusion que quoique chaque auteur ne trouve qu'un petit nombre de Desmidiées et que chaque auteur trouve toujours un nombre relatif très grand de nouvelles espèces, la flore Desmidiennne du Congo belge est cependant pauvre en espèces et le restera probablement le nombre de nouvelles formes diminuant proportionnellement avec le nombre de contrées examinées.

En comparant le matériel des différents auteurs, nous voyons une diversité très frappante ce qui prouve que les échantillons provenaient de biotopes très différents. Je repète ici textuellement ma conclusion de 1943, p. 8: „Les résultats des recherches faites jusqu'ici sont l'expression la plus frappante de la diversité écologique et phytogéographique des différentes contrées de notre colonie”.

D'autre part en examinant le facies général qu'on obtient en réunissant les résultats de tous les auteurs ensemble, on peut dire que quoique l'étude des Desmidiées du Congo nous révélera encore de nombreuses espèces, il est certain que le rapport des genres ne subira plus de changements importants et alors il est évident que certains genres, entre autres *Cosmarium*, sont représentés par un nombre très restreint d'espèces tandis que d'autres viennent en tête de liste.

Nous devons en conclure qu'au point de vue biogéographique non seulement les espèces comme telles ont valeur mais aussi le facies des flores ou faunes microscopiques.

Jusqu'à présent je puis affirmer ce fait en ce qui concerne les Rhizopodes (van OYE 1948) et l'étude présente nous prouve que les mêmes conclusions peuvent être faites pour les Desmidiées.

En fin de compte nous pouvons faire les conclusions générales suivantes concernant le Congo belge.

1° La flore Desmidiennne du Congo belge est très pauvre surtout en comparaison avec les autres pays tropicaux ;

2° La flore Desmidiennne du Congo belge a un facies propre qui la distingue de ellecs de tous les autres pays tropicaux ;

3° Les espèces filamenteuses connues des autres pays sont rares au Congo mais certaines espèces de genres représentés par des exemplaires vivant librement présentent au Congo souvent une tendance à se grouper en filament: *Pleurotaenium* ;

4° Le genre *Cosmarium* est représenté par un nombre relativement très petit et ne prend jamais le développement que ce genre présente dans les flores Desmidiennes des autres pays.

5° Il y a un nombre assez grand d'espèces de Desmidiées qu'on rencontre à l'est du Congo belge et à l'ouest des Monts de

Cristal. Ceci est en rapport avec la g n se g ologique du centre de l'Afrique.

Enfin, chose bizarre, nous voyons qu'au Congo le plus souvent une esp ce d'un genre est pr pond rante. Le fait que plusieurs esp ces tr s voisines se pr sentent en m me temps dans le m me  chantillon comme c' tait le cas pour les *Closterium K tzingii*, *setaceum* et *rostratum* est jusqu'  pr sent non seulement une exception pour ces trois esp ces, mais aussi pour tous les autres genres.

Le contraire est tr s frappant en ce qui concerne le genre *Micrasterias* qui, quand il se rencontre, est presque toujours repr sent  par une seule esp ce.

Ceci se remarque d'une fa on tr s nette en comparant mes diff rentes publications sur les algues du Congo Belge:

Micrasterias apiculata (EHRENBERG) MENEGHINI var. *tjitjerkensis* BERNARD Environs de Stanleyville

Micr. crux-melitensis (EHRENBERG) HASSALL Bas-Congo

Micr. crux-melitensis (EHRENBERG) HASSALL var. *bogoriensis* BERNARD Environs d'Eula

Micr. foliacea BAILLY Bas-Congo

Micr. Jenneri RALFS var. *simplex* W. & G. S. WEST Nord du lac Kivu

Micr. Lebrunii van OYE Nord du lac Kivu

Micr. papillifera de BREBISSON Bas-Congo

Micr. apiculata (EHRENBERG) MENEGHINI var. *Evensi* van OYE Bas-Congo.

Nous pouvons observer le m me fait pour les esp ces du genre *Pleurotaenium*.

Les esp ces du genre *Closterium* montrent  galement, mais d'une fa on moins nette, une r partition en concordance avec les faits observ s pour les genres *Micrasterias* et *Pleurotaenium*.

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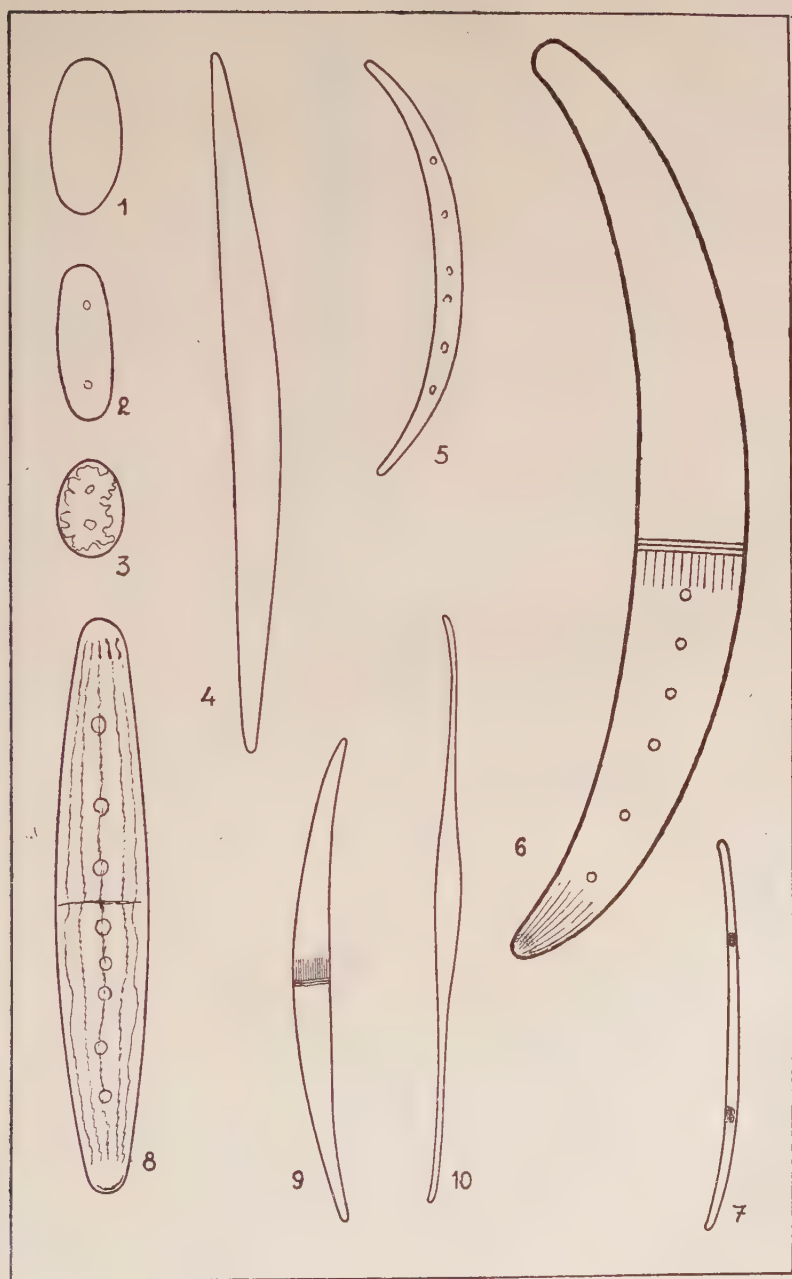
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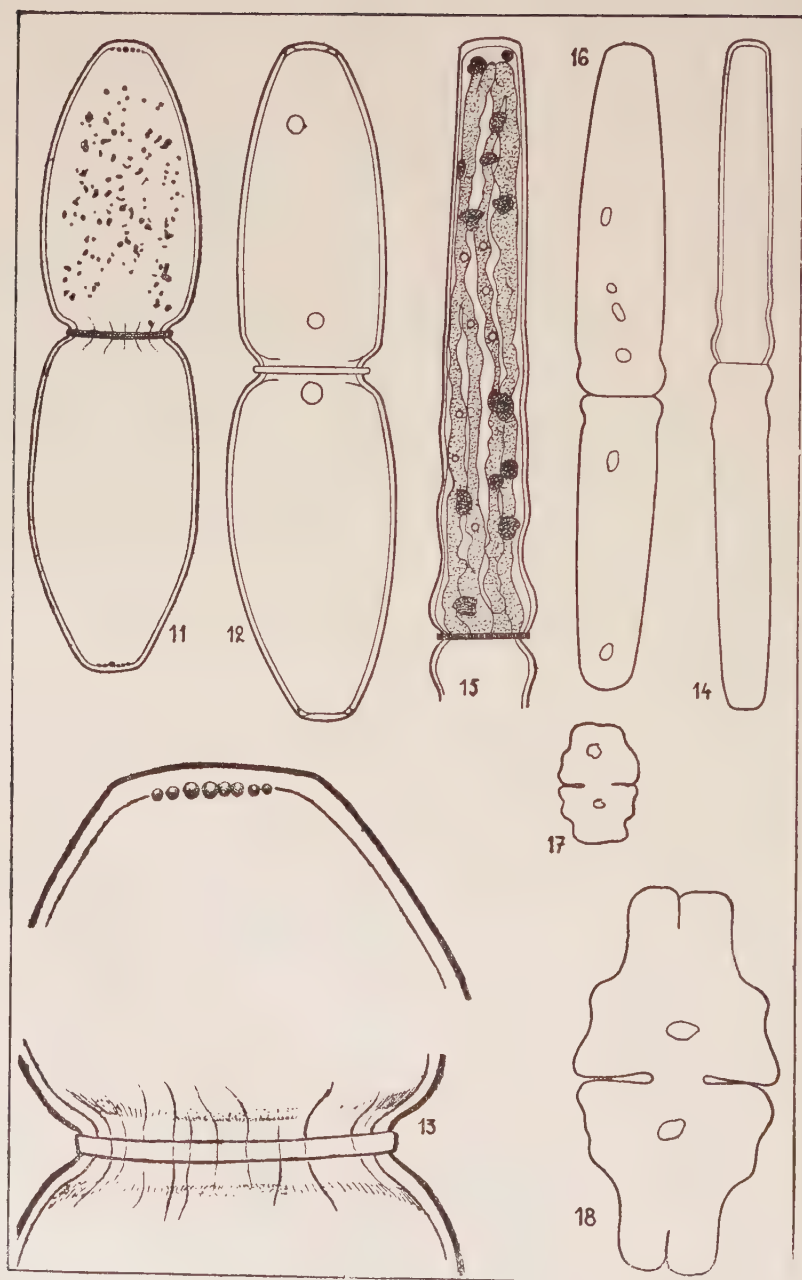
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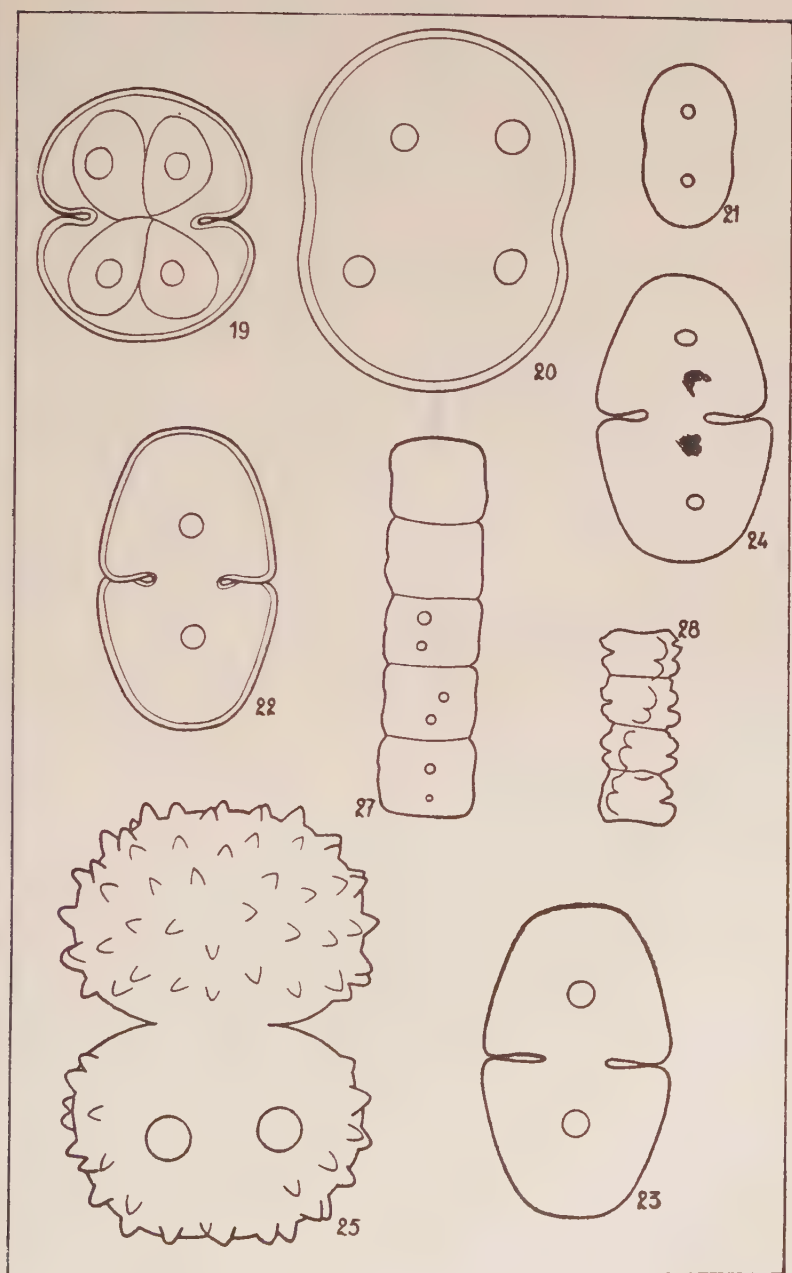
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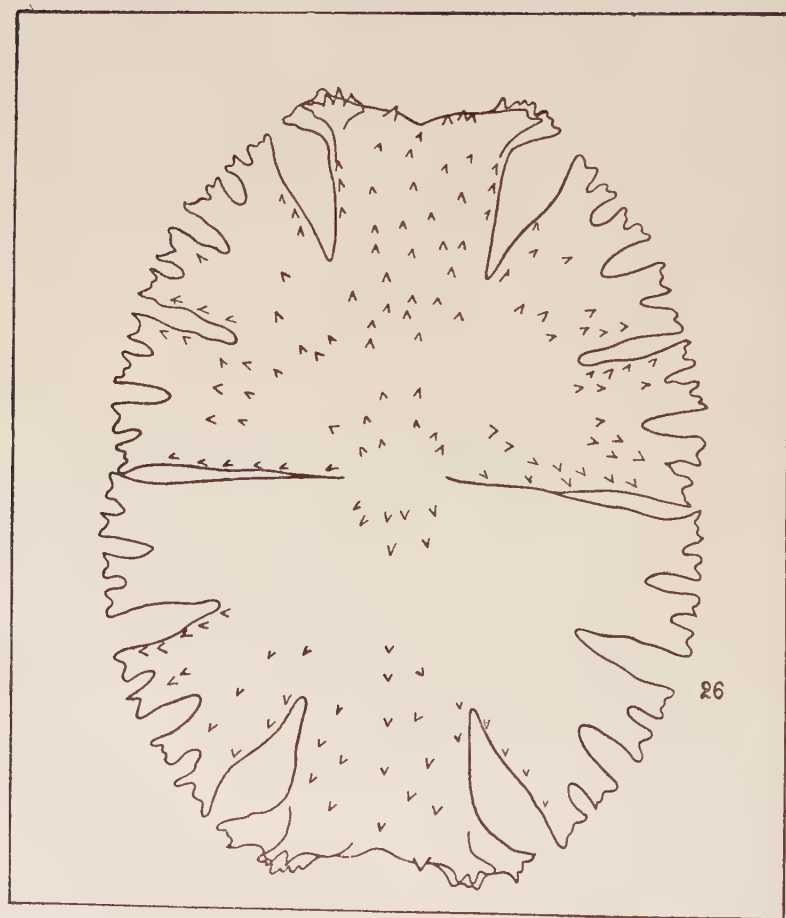
LÉGENDE DES FIGURES.

1. *Cylindrocystis Brebissonii* MENECHINI.
2. *Cylindrocystis Brebissonii* var. minor W. & G. S. WEST.
3. *Cylindrocystis crassa* de BARY.
4. *Closterium acerosum* (SCHRANK) EHRENBERG.
5. *Closterium cornu* EHRENBERG.
6. *Closterium costatum* CORDA var. *Westii* (CUSHMAN).
7. *Closterium juncidum* RALFS.
8. *Closterium libellula* FOCKE var. *intermedium* (ROY & BISSETT) G. S. WEST.
9. *Closterium Falfsii* de BREBISSON var. *hybridum* RABENHORST.
10. *Closterium setaceum* EHRENBERG.
- 11, 12, 13. *Pleurotaenium congolense* n. sp.
- 14, 15. *Pleurotaenium trabecula* (EHRENBERG) NAEGELI.
16. *Pleurotaenium trabecula* (EHRENBERG) NAEGELI var. *crassum* WITTROCK.
17. *Euastrum minutum* n. sp.
18. *Euastrum securiformiceps* BERGE.
19. *Cosmarium circulare* REINSCH.
20. *Cosmarium connatum* de BREBISSON.
21. *Cosmarium cucurbita* de BREBISSON.
- 22, 23, 24. *Cosmarium pseudopyramidatum* LUNDELL var. *glabra* n. var.
25. *Staurastrum polytrichum* (PERTY) RABENHORST.
26. *Micrasterias apiculata* (EHRENBERG) MENECHINI var. *Evensi* n. var.
27. *Hyalotheca dissiliens* (SMITH) de BREBISSON.
28. *Desmidium Swartzii* AGARDH var. *amblyodon* (ITZIGSOHN) RABENHORST.









Copulation observed in *Viviparus fasciatus* (O. F. Müller)

by

Ole SYLVEST, Copenhagen.

A description of the copulation in *Viviparus fasciatus* (O. F. Müller) (= *V. lacustris* (Beck)) seems not to have been published previously. Considering the peculiar genital anatomy of these prosobranchs, the right tentacle of the male encloses, as will be known, a penis, it is understandable that several investigators previously have been anxious to get an opportunity to watch a copulation. F. LEYDIG (1850) thus expresses his regret that he never succeeded in surprising a pair of these animals in copulation, "so interessant es auch wäre".

He believes it is due to the fact that these gastropods are shy and wary, qualities which in his opinion become more pronounced the longer they are kept in captivity. C. WESENBERG-LUND (1939) too has tried in vain to observe copulation and likewise underlines the wariness of the animals. He presumes that copulation may take place at night and may be dependent on definite seasons. As regards the closely allied *Viviparus contectoides* (W. G. Binney) H. J. VAN CLEAVE and L. C. LEDERER (1932), who also did not succeed in observing copulation either in the field or in the laboratory, state the following regarding the presumed time of copulation. On the basis of an examination of a large number of *V. contectoides*, partly from central Illinois, partly from central New York, they are able to ascertain that parturition of these animals in the former locality occurs from February to May with a maximum in March and April, and in the latter locality from March to June with the greatest production in April and May. Since there is a period of several weeks following the act of parturition during which all females are nongravid, the author says, it seems probable that copulation and fertilization occur soon after the brood is discharged, for with great regularity a new brood has filled the marsupium by late summer.

Although Denmark is situated in a more northern latitude than the two American biotopes in question, and though it will — always be fairly unsafe to conclude from one animal to its — congener, we might nevertheless expect, provided that Cleave's and Lederer's considerations be right, that we have the biggest

chance of finding these animals in copulation during spring in this country.

I must however admit that I was quite unaware of these conditions when on May 26th 1946 I caught two fully grown specimens of *Viviparus fasciatus*, a male and a female, in the river Susaa on Sjælland. In the evening the animals were placed in a jam glass with fresh tap water.

Next morning on May 27th at 7.15 a.m. (summer time) the animals were found to be in such position that it could be supposed that a copulation was in progress. The female was sitting on the one side of the glass with the caudal end downwards and the tentacles at the surface of the water. The foot of the male was placed on the shell of the female in such a way that a portion of the last and a little of the basal part of the last but one whorl was covered (see the half-schematical figure). The caudal end of the male was orientated towards the left side of the female, while the head of the male reached to the right side of the shell opening of the female. The head of the male here was turned nearly at right angles to the left in relation to its body, whereby its right tentacle was off the right side of the female and disappeared after having been bent round the margin of the shell opening, being extended or stretched into the right part of the shell opening of the female. It could not be ascertained if the tentacle of the male connected with the genital opening of the female, as this was not observable. The male was sitting motionless, whereas the female now and then made rocking movements



with the shell from one side to the other, however without moving the foot. Observations had to be interrupted at 7.55 a.m., but the animals had not changed their position at that time. At

9.30 a.m. observations were continued by my wife. At that time the female sat on the bottom of the glass, while the male was still sitting motionless in the same position as previously. At 11 a.m. the male had with drawn its right tentacle somewhat so that it just touched the margin of the mouth of the female. At 11.30 a.m. the tentacle of the male was no longer in connection with the shell opening of the female, but the male sat until 1.30 p.m. on the shell of the female without having moved its foot the slightest bit since observations had begun in the morning. Not until 2.30 p.m. when the animals were observed again did they creep about separately in the jam glass.

A few days later I succeeded again in observing another pair, caught in the river Ladegaardsaa in Copenhagen, in copulation in an aquarium at 12 p.m. The position was exactly as that described above.

The fact that I succeeded in the course of a few days in observing two pairs of *Viviparus fasciatus* in copulation, while other investigators were unsuccessful, supports the hypothesis that the animals have a definite seasonal time of copulation. A further study of the reproductive organs of the females in conformity with van Cleave's and Lederer's above mentioned investigations may throw more light on this problem.

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Einige neue Notommatidae-Arten (Rotatoria) aus Schweden

von

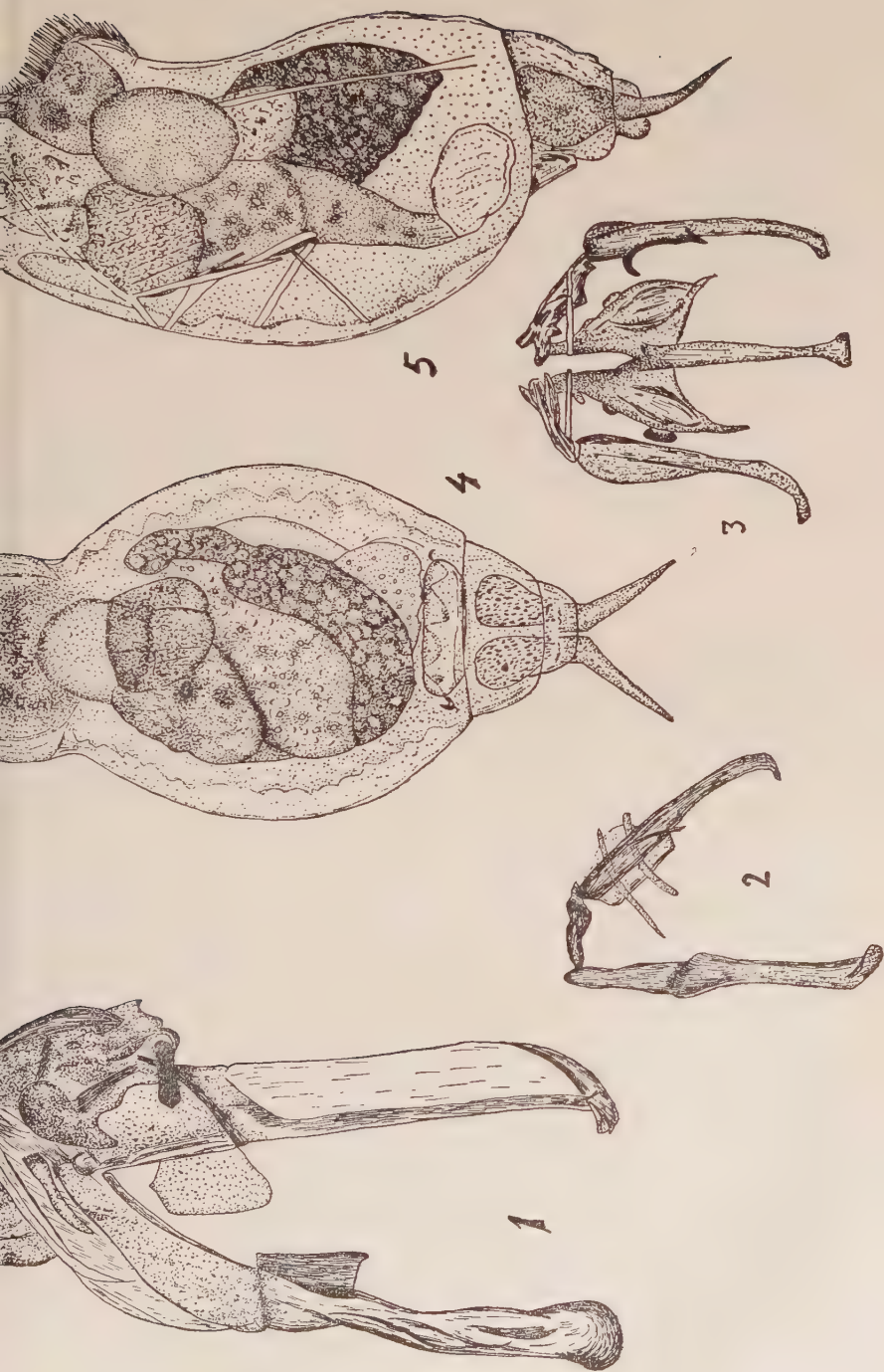
Bruno Bérzinš.

Bei der Untersuchung der schwedischen Rotatorien wurden viele neue Arten sowohl für Schweden, wie auch für Europa gefunden. Es wurde auch eine Reihe für die Wissenschaft neuer Arten entdeckt. Im folgenden gebe ich kurze Beschreibungen und Abbildungen von einigen dieser neuen Arten. Die ökologischen Ergebnisse über diese Tiere aus dem Aneboda-Gebiet werden in der Zukunft in einer gemeinsamen Arbeit für eine grössere Anzahl von Rotatorien-Arten mitgeteilt.

Notommata falcinella europaea subsp. n. (Fig. 1)

Meine *Notommata falcinella* Individuen aus dem Aneboda-Gebiet gleichen in vielen Punkten mehr den Teiren, die WULFERT aus Deutschland gemeldet hat, als diejenigen, die von HARRING & MYERS aus Amerika beschrieben wurden. Auch in Aneboda bei diesen Tieren beobachtete ich eine ähnliche Segmentierung, wie dieselbe an den WULFERT'schen Objekten bekannt ist. Die schwedischen Tiere besaßen auch die sehr grossen und auffälligen Oralplatten. Dagegen wurden die Pleuralstäbe nicht gesichtet. Beim Vergleich der Abbildungen erwies es sich, dass diese Tiere bei HARRING & MYERS sowie bei WULFERT keinen lamellaren Anhang am Fulcrum haben.

Wenn auch die Körpermasse der von mir untersuchten Tiere ungefähr dieselbe wie bei den anderen Autoren ist, dennoch scheinen die Trophen bei meinen Tieren etwas massiver gebaut zu sein. Es ist sehr schwer anzunehmen, dass solche sorgfältigen Beobachter, wie die beiden amerikanischen Forscher, bei ihren Objekten die riesigen Oralplatten nicht bemerken konnten. Es ist so, dass die europäischen Tiere von *Notommata falcinella* eine eigene selbstständige Subspezies bilden: *Notommata falcinella europaea* subsp. n. Es scheint, dass WULFERT's Tiere nicht zu dieser Subspezies gehören, denn sie stimmen nicht in allen Merkmalen mit meinen Tieren überein. Bei meinen Tieren fehlen die Pleuralstäbe, dagegen haben sie einen lamellaren Anhang am Fulcrum.



Die Masse der Tiere:

	Meine Tiere	Harring & Myers	Wulfert
Totallänge	450–500 μ	500–550 μ	500–550 μ
Zehenlänge	30–31 „	30–33 „	30–33 „
Kauerlänge	85 „	75 „	75 „
Kauerbreite.	72 „	—	—
Länge von Fulcrum	56 „	—	60 „
Länge der Manubrien	56 u. 58 „	—	52 u. 67 „
Länge von Rami	40 „	—	42 „
Länge der Unci	30 u. 36 „	—	32 u. 38 „
Kauerbreite ohne Oralplatten	80 „	—	—
Kauerbreite mit Oralplatten .	112 „	—	—

Die Tiere wurden ziemlich oft auf den Hochmooren im Ane-boda-Gebiet, Småland, gefunden: Byggetsgöl, Åkhult. Seltener in Flachmooren kamen diese Tiere vor: Frännehåle. Doch immer wurden die Tiere nur vereinzelt gefunden. (Sommer 1945–1947).

Notommata Gisléni n. sp. (Fig. 2–5)

Dieses Tier ist klein, doch gedrun-gen, kräftig gebaut. Der ab-gerundete Kopf ist scharf von dem Körper markiert, besonders in dorsoventraler Ansicht. Körper: tonnenförmig, de rauf der ventralen Seite nicht aufgeblasen, sondern eingezogen ist. Fuss: kräftig, besonders das Basalglied. Die Zehen sind mittellang, in lateraler Ansicht leicht ventralwärts gebogen, in dorsaler oder ventraler Ansicht am Grunde mit einem Knick (sehr deut-lich am Innenrand sichtbar), dann nach aussen gebeugt. Körper sehr durchsichtig. Das Wimperfeld liegt auf der ventralen Seite. Auf der oberen Seite des Kopfes ist eine trichterartige, kleine Vertiefung und daneben sind einige kleine Zilien. Was für ein Organ damit gebildet ist, kann ich nicht sicher entscheiden. Dotterstock — gross; Magen scheint in zwei Abteilungen geteilt zu sein. Die Magendrüsen sind ziemlich gross. Die Fussdrüsen sind sehr gross, fast den ganzen Fuss einnehmend. Kauer mittel-gross. Fulcrum am Ende nach innen gebogen, am distalen Ende erweitert (in Dorsalansicht). Rami ungleich, ebenso Manubrien, so dass der Kauer eine asymmetrische Aussicht erhält. Rami haben Alulae, von denen das linke länger als das rechte ist. Am Rande vom Ramus (besonders beim linken Ramus) ist ein gerundetes, knollenförmiges Gebilde. Manubrien gebogen, am distalen Ende hakenförmig nach innen gekrümmt; am proximalen Teil sind sie plattenförmig erweitert. Neben ihnen liegen zwei Pleural-stäbe. Unci ungleich gross, mit starken Zähnen. Augen fehlen.

Grösse der Tieren:

Totallänge	134-168 μ
Zehenlänge	14-15 „
Kauerlänge	24-25 „
Kauerbreite	22-23 „
Fulcrum	15 „
Manubrium	20 „

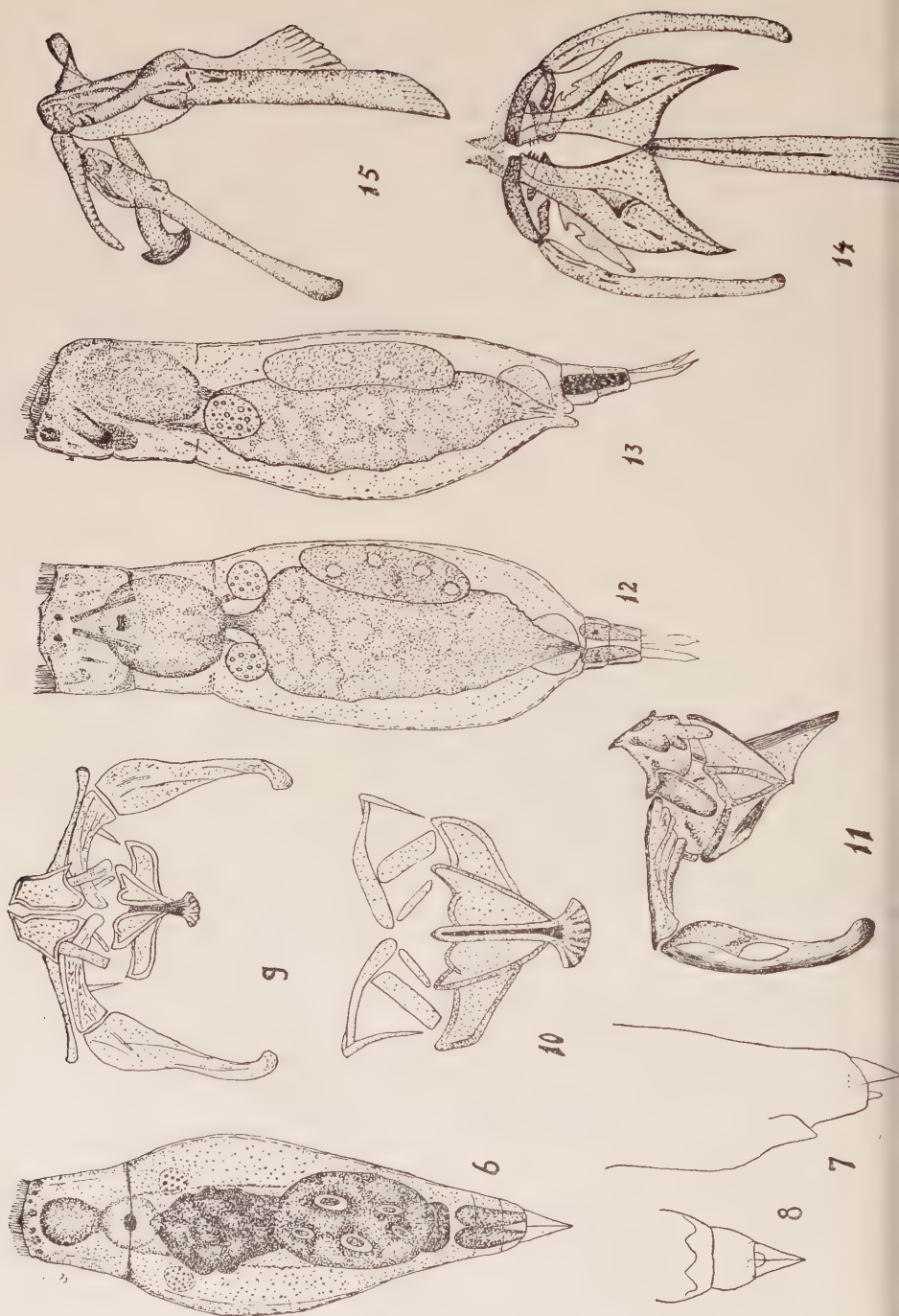
Es wurden einige Individuen in den Seen Fiolen und Sträken (Sommer 1946) im Aneboda-Gebiet beobachtet. Dieses Notommatid in seiner Ausbildung des Kauers gleicht mehr *Notommata paracyrtopus* Beauchamp, doch hat es viele Abweichungen in der Ausbildung der Manubrien, Unci u.a. Noch grösser ist der Unterschied in der habituellen Ansicht. Wegen der sehr charakteristischen Körperbildung, der Zehen und des eigentümlichen Frontalorgans am Kopf ist diese Art gut gekennzeichnet.

Dem früheren Präfekten des Limnologischen Instituts in Lund, Professor T. Gislén, zu Ehren nenne ich diese Art *Notommata Gisléni*.

Proales tyrphosa n. sp. (Fig. 6—11)

Der längliche Körper ist breiter als der Kopfteil. Die grösste Breite des Körpers liegt im vorderen Teil; nach hinten zu geht der Körper ununterbrochen in den zweigliedrigen Fuss über. Der Körper farblos. Das Wimperfeld am Kopfende liegend. Die Wimperohren sehr klein, gewöhnlich unsichtbar. An der Dorsalseite der Körper mit einer Falte endigend; diese Falte liegt auf dem proximalen Russglied und ist mit zwei Sinussen ausgebuchtet. Fuss an dorsaler Seite mit einem kleinen Anhang endigend. Die Zehe kurz, kräftig, wie in lateraler so auch in dorsaler Ansicht dreieckig; fast immer in der Mediallinie sich zusammenschliessend. Der Magen gross, lang und traubenförmig. Die Magendrüsen gross, kugelig. Das Ovarium gross, mit grossen Kernen. Die Fussdrüsen sind ziemlich gut entwickelt. Die Blase klein. Das Ganglion rundlich, enthält das linsenförmige Auge. Mastax gross; Trophi regulär und kräftig. Fulcrum kurz, gerade, lateral zusammengedrückt, am Ende erweitert. Alulae schmal, am unteren Ende gerundet; kleine Spitzen nur an den oberen Teilen vorhanden. Ramus nach oben erweitert, dreieckig, ohne Zähne. Manubrium massiv, am unteren Teil nach innen gebogen. Der Epipharynx wird von zwei Platten gebildet, die an den oberen Ecken einen scharfen Zahn bilden.

Totallänge	182 μ
Zehenlänge	13 „
Trophenbreite	48 „
Trophenlänge	31 „



In der Sedimentschicht der *Carex rostrata*-Zone im Byggetsgöl (Aneboda) im Sommer 1945 gefunden, in kleiner Anzahl.

Eothinia lamellata n. sp.
(Fig. 12—15)

Körper länglich, kräftig. Kopf und Nackensegment breiter als lang, die abgrenzenden Falten gut sichtbar. Körper an dorsaler Seite mit einem kleinen Lappen endend. In Seitenansicht der Körper auf der dorsalen Seite etwas aufgewölbt. Ventralseite fast gerade. Fuss nicht massiv, zweigliedrig. Zehen zylindrisch, am Ende kegelförmig und spitz; in Lateralansicht ist es deutlich sichtbar, dass nur die dorsale Seite der Zehen schief ist. Wimperfeld terminal gelegen. Die dorsalen und lateralen Antennen sind nur kleine Erhebungen.

Kauer kräftig, virgaten Typus. Fulcrum lang und gerade. Sein posteriores Ende in Fibrillen gespalten, gleich wie bei *Eothinia elongata*. Auf dem Fulcrum eine grosse, am Ende zersplitterte Lamelle, welche nur in Lateralansicht gut zum Vorschein kommt. Rami gross, dreieckig, symmetrisch gebaut, mit Alulae. Am Oberteil der Rami wenige, normal 3 Zähne. Unci an der Unterseite einen Anhang besitzend. Manubrii kürzer als Fulcrum, ein wenig nach innen gebogen. Kleines, scharfes Epipharyngealgebilde vorhanden. Die Rami von kleinen Platten (Oralplatten!) bedeckt. Ganglion klein, saccat. Mit Augen. Mit Blase. Die Fussdrüsen nehmen die beiden Fussglieder ein.

Totallänge	340 μ
Zehenlänge	33 „
Kauerlänge	60 „
Kaubreite	41 „

Es gleicht *Eothinia elongata* (Ehrbg.), doch weicht in dem Körpergehalt und der inneren Organisation, aber besonders in der Kauerausbildung ab. Es wurden einige Tiere in den Kiesgruben am Frännehåle-Moor, Aneboda (Sommer 1945, 1946) und in den überfluteten Flachmoorufer der Förhult-See gefunden (Sommer 1945).

Eothinia elongata macra n. subsp.
(Fig. 16—17)

Von der typischen Art unterscheidet es sich mit seinen grösseren Massen. Der Fuss ist kürzer, gedrungener; abdominaler Teil des Körpers ohne zylinderförmiger Einengung. Rami mit wenigen aber relativ langen Zähnen. Unci kräftiger, als bei der typischen Art, mit einer scharfen Biegung nach unten. Manubrien im oberen Teil gebogen. Kräftig entwickelter Epipharynx. Ueber den Rami sind Platten (Oralplatten?) vorhanden.

Totallänge	460 μ
Zehenlänge	44 „
Kauerlänge	61 „
Kauerbreite	46 „

In kleiner Anzahl im See-Fiolen auf *Potamogeton natans* im Sommer 1945 gefunden.

Eothinia lasiobiotica n. sp.

(Fig. 18—21)

Körper kräftig, von länglicher Gestalt. Kopf zylindrisch, die Kopfsegmente gut sichtbar, breiter als lang. Wimperfeld terminal liegend, mit ein wenig verlängerten lateralen Wimpern. Körper in der Mitte breiter, auf der ventralen Seite nur ein wenig, auf der dorsalen Seite stark aufgewölbt; die dorsale Aufwölbung sieht wie eine Ueberdachung der Fussbasis aus. Fuss zweigliedrig. Die Zehen am Grunde knollenartig aufgeblasen, weiter sind sie dünn, leicht ventralwärts gebogen. Fussdrüsen sehr gross, noch in das Körperhinterende hineinreichend. Fulcrum am Ende nach innen gebogen. Rami triangulär, ohne Zähne am Innenrand. Mit Alulae. Unci gebogen, an der Innenseite mit Zahn. Manubrien gerade, mit ziemlich grossen Basalplatten auf beiden Seiten, nur etwas länger als Fulcrum. Mit Blase. Ganglion gross, saccat. Mit einem cervikalen Auge und zwei accessori-schen Augen am Frontalrand.

Totallänge	225 μ
Zehenlänge	25 „
Kauerlänge	26 „
Kauerbreite	25 „

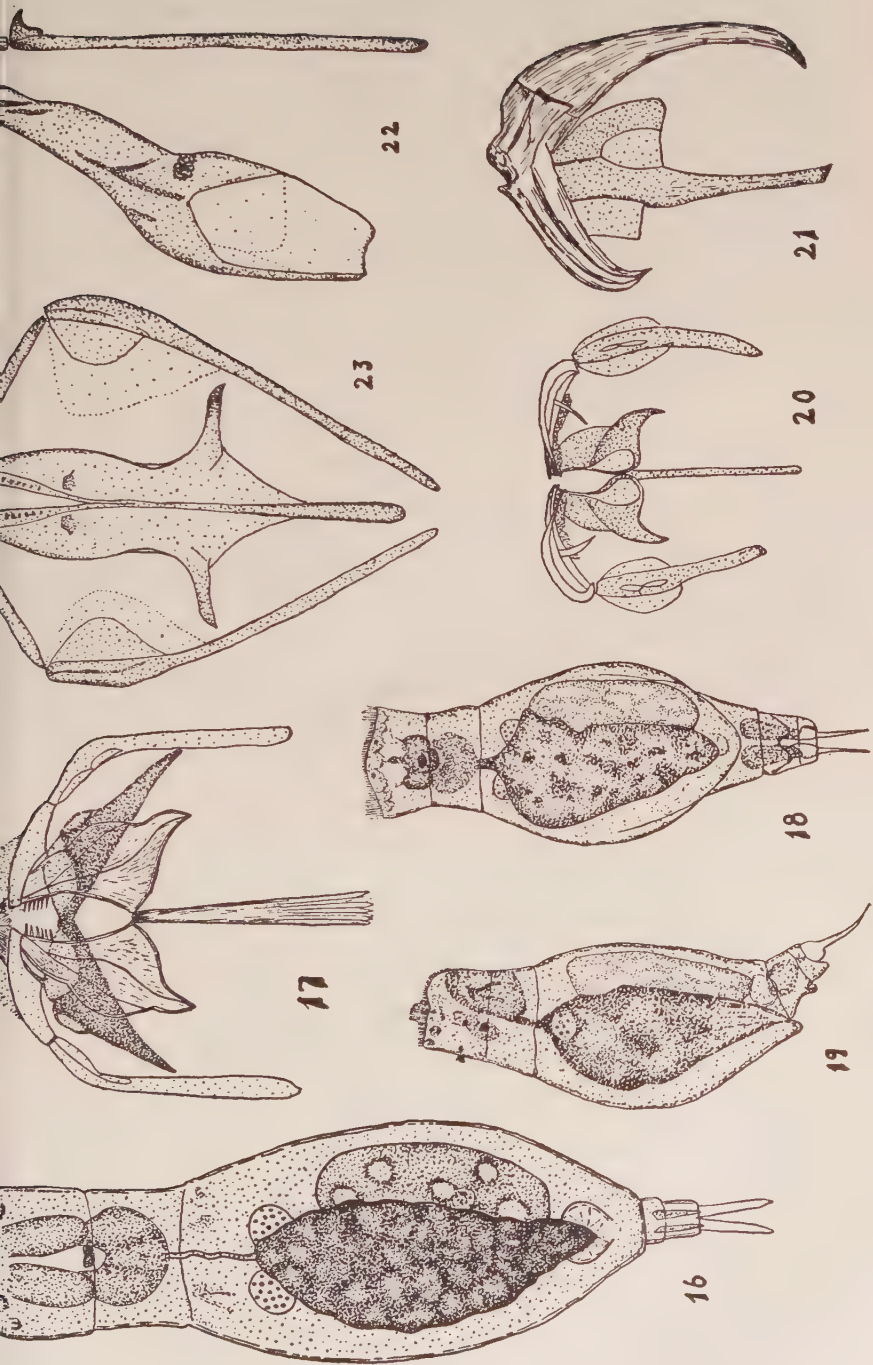
Sehr nahstehende Art der *Eothinia triphaea* Harr. & Myers. Es besteht ein Unterschied in der Bezeichnung der Rami im Kauer, in der Körpergestalt, in der Ausbildung von dem ventralen Zahn der Unci, aber besonders durch das Vorhandensein der kleinen, in der Mitte ausgebuchteten Falte über dem basalen Fussglied. Eine solche Falte fehlt an *E. triphaea*.

Kommt an verschiedenen schwimmenden Pflanzen im See-litoral vor, hauptsächlich an *Myriophyllum alterniflorum*. In den Sommern 1945—1947 regelmässig, aber nicht in grosser Anzahl in den Seen Allgunnen, Föhrhult, Hack, Lammen, Berg, Fiolen, Skärshult, Stråken, gefunden. Dann noch in den Aneboda Fischteichen und im Kopparås-Moor gesichtet.

Dicranophorus robustus minor n. subsp.

(Fig. 22—23)

Von der typischen Art und von var. *europaea* zuerst mit seiner



viel kleineren Gestalt sich unterscheidend. Die Zehen sind kürzer als bei Nominatform und var. *europaea*. Dagegen Mastax viel kräftiger gebaut. Es gibt einige Unterschiede im Bau des Kauers. Ebenso wie bei der typischen Form laufen die Alulae der Rami senkrecht der Längsachse des Fulcrums. Auf der Oberfläche der Ramus-Mitte (in der Höhe am Anfang der Rami-Zähne) jederseits eine Erhöhung mit gerade abgestutztem Ende. Manubrien am inneren oberen Teil mit Doppellamelle: am Manubrium anschließende Lamelle dicker, die grössere viel dünner. In Lateralansicht hat das ganz gerade Manubrium eine hakenförmig umgebogene Spitze.

Totallänge	200 μ
Zehenlänge.	35 „
Kauerlänge	53 „

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Erklärung der Abbildungen.

Notommata falcinella europaea subsp. nov.

1. Kauer, lateral.

Notommata Gisléni spec. nov.

2. Kauer, lateral.
3. Kauer, ventral.
4. Tier, dorsal.
5. Tier, lateral.

Proales tyrphosa spec. nov.

6. Tier, ventral.
7. Körperhinterende, lateral.
8. Körperhinterende, dorsal.
9. Kauer, ventral.
10. Mittelteil des Kauers.
11. Kauer, lateral.

Eothinia lamellata spec. nov.

12. Tier, dorsal.
13. Tier, lateral.
14. Kauer, ventral.
15. Kauer, lateral.

Eothinia elongata macra subsp. nov.

16. Tier, dorsal.
17. Kauer, ventral.

Eothinia lasiobiotica spec. nov.

18. Tier, dorsal.
19. Tier, lateral.
20. Kauer, ventral.
21. Kauer, lateral.

Dicranophorus robustus minor subsp. nov.

22. Kauer, lateral.
23. Kauer, ventral.

Personalia

C. WESENBERG-LUND

by KAJ BERG.

If to-day a look is thrown into professor, dr. C. Wesenberg-Lund's home in Hillerød, you will find him diligently absorbed in his work; just now he is writing a book on freshwater zooplankton. On the 22nd of December 1947 he completed his 80th year, but he is still daily engrossed by his scientific work.

When a young man Wesenberg-Lund left Copenhagen and settled down at the banks of lake Furesø in a small laboratory. Since then he has lived and worked in nature. At lake Furesø he worked on classical ground; here in the eighteenth century the great Danish zoologist, Otto Frederik Müller, once lived. In many ways Wesenberg-Lund's studies are a continuation of his work. The following years a large series of publications were issued from this laboratory at lake Furesø, above all "Plankton Investigations of the Danish Lakes" 1904-08. Here Wesenberg-Lund shows the working method, which he applied later on: through regular collections from all the seasons of the year a material is procured, which illustrates the habits of freshwater organisms, their propagation, nutrition, temporal variation, local variation, periodicity and so on. In his papers, too, the existing, especially the older literature is taken highly into consideration. His works thereby acquire a monumental character. Furthermore it is characteristic of them that they are always profusely illustrated with his own beautiful drawings in Indian ink.

Through his comprehensiveness Wesenberg-Lund occupies an exceptional position among freshwater biologists. He has written about most of the animal groups of fresh waters. A work from the early years thus deals with the Bryozoa. The rotifers he has treated in a dissertation from 1899 and later also worked up in two large quartos and in "Handbuch der Zoologie". He has written about the freshwater Entomostraca of Greenland, about Plankton from Iceland, about the relict fauna in lake Furesø, about the litoral animal communities at the banks of the largest Danish lakes and about the dependence between the building of the plankton organisms and the temperature of the fresh water. In the last-mentioned paper the so-called buoyancy theory is proposed. He has studied marl deposits and peat in Danish lakes, chitinous and silicious remains in peat layers. Botanical



C. WESENBERG-LUND

subjects he has treated in studies on *Aegagropila sauteri*, *Zoothorellae* and *Stratiotes*. Hydrographical questions have been dealt with together with the chemist J. N. Brøndsted and in a work on some characteristic conditions of temperature in the littoral region of the Baltic lakes. Papers of general limnological character are the comparative studies on lakes in Scotland and Denmark, and "Furesøstudier", a bathymetric, botanical and zoological investigation on lake Furesø, published together with some co-operators. Finally Wesenberg-Lund has published a series of insectbiological investigations in "Internationale Revue der Hydrobiologie". They have a special charm through their abundance of observations, made on the adaptability of the animals to their milieu.

As the vicinity of lake Furesø was crowded with suburban buildings, Wesenberg-Lund moved his laboratory to Hillerød in North-Sealand, where it was placed in its own buildings at the expense of the Carlsberg-Foundation, and he, himself, was attached to the University of Copenhagen as a professor in 1922. From the laboratory of Hillerød he published a series of large works, a.o. studies on the Cercariae of the fresh waters. He collected his own principal results, those of his co-operators and others in two large volumes "Biologie der Süßwassertiere" (Wirbellose Tiere) 1939 and "Biologie der Süßwasserinsekten" 1943.

The above-mentioned scientific works and many others are especially familiar to the scientist of other countries. Less known is that professor Wesenberg-Lund has displayed large popular-scientific activities in Danish. In numerous articles and books he has made the Danish reading-world acquainted with freshwater-biological and other zoological investigations. Especially the bird kingdom has had his love. In him, the work for the preservation of natural beauty too has had an enthusiastic advocate. His popular work has obtained a rare favour because of the lyric mood, which marks it. Wesenberg-Lund is a passionate lover of the Danish scenery, in which he has lived during his whole life.

On professor Wesenberg-Lund's 80 years' day he was honoured from many sides. A deputation presented a medal as a gift from 135 Nordic biologists; it was accompanied by an address of the following wording:

Dear Professor Wesenberg-Lund,

On the occasion of your 80th anniversary Nordic biologists want to greet you and to congratulate you. On this day we feel compelled to honour you for the great and important scientific work, which you have carried out throughout a long life with indefatigable persistence. It has enriched us and pleased us, it has brought out your own name and the name of Denmark to remote countries and lent lustre to Danish zoology. Your love of nature marks your papers and books and fascinates the readers

through their lively style. Your delight at the beauty of nature is reflected in your numerous beautiful drawings and plates. Your love of Danish landscape, of field and forest, of lake and river, of the fauna of this country has been the motive in your many years' fight for the preservation of natural beauty. For all this everybody owes you thanks.

As a birthday present we beg you to receive a medal with your portrait, which we have had stamped by the Royal Mint. To us the copies of this medal shall be a symbol of the inspiration you have given and unceasingly give us ; and to you, professor Wesenberg-Lund, the medal shall be a token of our heartfelt congratulation, our thanks and our homage on this day !

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List of species collected during the expeditions of the "Hassler" (1871—1872), the "Albatross" and of Dr. Schmitt (1925—7 and 1935) in Perú and Chile. This paper follows two other writer's contributions (Algae &c, I. Marine Algae from Brazil, Am. Journ. Bot., 17: 627—634, pl. 39 and II. Marine Algae from Uruguay, Argentina, the Falklands Islands, and the Strait of Magellan, Pap. Mich. Acad. Sci., Arts & Letters, 24, 1938, I: 127—164, 7 pls.). Described as new are: *Chaetomorpha peruviana*, sp. nov.; *Ch. p.* var. *elongata*, var. nov.; *Bryopsis peruviana*, sp. nov.; *Colpomenia sinuosa* f. *lacunosa* f. nov.; *Gelidium congestum*, sp. nov.; *Halymenia foliacea*, sp. nov.; *Sebdenia* (?) *chichensis*, sp. nov.; *S.* (?) *afuerensis*, sp. nov.; *Gigartina paitensis*, sp. nov.; *Cryptopleura peruviana*, sp. nov.; *Hemineura Hassleri*, sp. nov.; *Laurencia paitensis*, sp. nov.

WM. M. SPRULES, An ecological investigation of stream insects in Algonquin Park, Ontario. Un. of Toronto Studies; Biol. Ser. No. 56, Publ. of the Ontario Fisheries Res. Lab., No. 69, 1947, 80 pp., 11 fig.

Condensed Summary. — 1. An Investigation of the quantitative and qualitative distribution of insects in streams of Algonquin Park, to determine the effect of different environmental conditions on the distribution.

2. The cage-trap method (sampling the emergence of insects from unit areas) was used because of its applicability to the diverse habitats.

3. Data were obtained from 10 stations on the Madawaska river system.

4. The total number of insects which emerged in a 24 h. interval was approximately twice that obtained when onyl one collection was made instead of 24.

In general anyone species emerged at the same time each day and different species emerged at different hours throughout a 24 h. interval. The maximum total emergence from a rocky riffle in midsummer occurred at 11 p.m. each day, the majority of insects emerging between sundown and midnight.

6. Severe fresher scouring the bottom in some areas reduced the insect population, through molar action and owing to dislodgment and loss of individuals; the effect of the freshet was minimized in areas with a relatively stable bottom consisting of large particles which afforded shelter.

7. An intermittent flow and consequent drying of the stream bed limited the number of individuals and species present. Species of fixed habit (some Trichoptera, Simuliidae) were eliminated rapidly, while the freeroving forms (nymphs of Ephemeroptera) were able to follow the receding water and so escaped.

8. An immediate reduction in the number of individuals and species was brought about by the transformation of a shallow rocky rapids into a deep sedimental pool by a beaver dam, as large groups of insects depending on current for respiration and feeding were eliminated and not compensated by a smaller group of quiet-water species. A few species showed a wide habitat tolerance.

9. Different types of bottom in a restricted section of the stream also influenced the number of species and individuals. Rocky riffles were most productive, following them were gravel, muck and sand bottoms. The utilizable microhabitats, varying with the bottom type, influenced the diversity of the various faunas. It has been suggested that the number of insects present in any area is related to the habitable surface area of bottom particles exposed to the water.

10. Distance from the source of the stream also influenced the composition of the fauna of rapid riffles. Species found in the upper reaches of the stream were progressively eliminated and replaced by species found in the lower reaches. A direct correlation was found between the total change in the number of species in successive riffles at different distances from the source and the average summer water temperature.

11. Differences in termal requirements resulted in a seasonal segregation of the emergence period of different species; these merged in the same order each year. Differences noted for each species were probably due to differences in the water temperatures during the development period.

12. Species were found in widely separated sections of the stream providing the temperature in these areas were suitable for the development of the species.

13. The quantative and qualitative distribution of insects observed in streams results from the complex interaction of many environmental factors; fundamental ones are temperature, nature and configuration of the bottom particles, and rate of flow.

J. S. HART, Lethal Temperature Relations of certain Fish of the Toronto Region. Trans. R. Soc. Canada, XLI (III), 1947, 57—71, 5 tables.

Summary. — Lethal temperature relations were determined over the whole range of thermal acclimation for eight species of fish from the Toronto region. The experiments involved the determination of (1) the upper and lower incipient lethal temperatures bounding the zone of tolerance (the range of survival) and (2) the upper thermal resistance time or the periods during which temperatures above those which will be ultimately lethal are withstood.

The tests extend the scope of the previous investigations in pointing out the diversity of the lethal temperature patterns. The comparative lethal thermal data have been tabulated.

Thermal tolerance measurements indicated that the species here were in general intermediate in eurythermicity between *Salvelinus fontinalis* on the one hand (625 units) and *Carassius auratus* on the other (1,220 units). They ranged between 747 and 903 units. Upper ultimate incipient lethal temperatures tended to follow the degree of eurythermicity of the species and ranged from 29.3 to 33.3° C.

No correlation was found between size or age and the order of death at a given lethal temperature.

F. E. J. FRY & J. S. HART, Cruising speed of Goldfish in Relation to Water Temperature. J. Fish. Res. Bd. Can. 7 (4) 1948, 169—175.

Summary. — 1. The cruising speed of young goldfish was measured by placing them in an annular glass walled chamber capable of being rotated at various speeds.

2. The cruising speed of goldfish which are thermally adapted to the temperature at which the speed is measured rises steeply over the temperature range from 5 to 20° C., remains fairly constant to 30° C., and then drops with considerable rapidity. It can be estimated by interpolation that a flat peak occurs in the neighbourhood of 28° C.

3. The cruising speeds of goldfish acclimated to temperature levels of 5, 15, 25, and 35° C. and measured over the biokinetic range appropriate to each level of acclimation, display four distinct curves.

4. The final preferendum for the goldfish and the optimum temperature for cruising speed in thermally adapted fish correspond closely.

5. The optimum temperature, however, is not sharply defined for thermally adapted fish perform almost equally well over the range from 20 to 30° C.

6. There is not always a direct correspondence between the optimum temperature for cruising speed and the preferendum in fish that are adapted to one particular temperature level.

F. E. J. FRY & J. S. HART, The Relation of Temperature to Oxygen Consumption in the Goldfish. Biol. Bull. 94, 1, 1948, 66—77, 6 fig.

Summary. — 1. Two levels of oxygen uptake, (1) the lowest point in the resting metabolism in the daily cycle and (2) the maximum steady rate of oxygen uptake found when the fish were stimulated to activity in a rotating chamber, were measured at temperatures from 5° to 35° C.

2. The standard (resting) rate was measured over levels of oxygen high enough to avoid any dependence of the rate on oxygen tension. The maximum rate was measured over a series of oxygen tensions down to the asphyxial level.

3. The standard rate continued to increase with temperature up to 35° C., the highest temperature at which observations were made. The maximum rate was found by interpolation to reach its highest value at about 35° C. and to remain steady or to decrease slightly at higher temperatures.

4. The maximum rate of oxygen uptake became dependent upon the oxygen tension between 15 and 40 mm. Hg, depending upon the temperature. These estimates were made in a closed system in which there was an accumulation of the carbon dioxide released in respiration.

5. Oxygen tensions at which the maximum oxygen uptake met only the needs of the standard metabolism were estimated to be between 4 and 25 mm Hg over the temperature range investigated.

6. At the various temperatures the difference between the maximum and standard metabolic rates is correlated with the rate at which goldfish can swim steadily.

7. It is concluded that the drop in the sustained swimming rate of goldfish at temperatures from 30° to 38° C. is probably due to a decrease in the metabolism available for external work rather than to the thermal destruction of enzymes.

G. ABDIN, Physical and Chemical Investigations relating to Algal Growth in the River Nile, Cairo. Bulletin de l'Institut d'Egypte, XXIX (1946—1947), 1948, 19—44, 6 fig.

Summary and Conclusions. — A study of the River Nile and

its biological contents in the vicinity of Cairo has been made from January 1941 to August 1942. The work includes physical and chemical characteristics of the river and its biological aspects.

The following are some of the more general conditions concerning the nature of plankton and the physical and chemical factors affecting its distribution.

1. Owing to the seasonal character of the tropical rainfall from which the Nile derives its supplies the volume of water carried by the river varies greatly during the seasons of the year and its level consequently undergoes seasonal rise and fall of several metres. The period of low water occurs in May and June and high water occurs in August and September.

2. The plankton of the river is subject to fluctuations depending on the stage of the river. During the rise of the river (August and September) the plankton is almost entirely replaced by detritus and silt.

3. Phyto-plankton of the River Nile near Cairo is composed mainly of green algae, blue green algae and diatoms. This agrees with the results of many other observations made on different American and European rivers.

4. The water of the River Nile is characterised by a lack of any marked depletion of any nutrient substances like phosphates, nitrates or silica. Diatoms occur when water is rich in nitrates, phosphates, silica and calcium. Colonial green algae and desmids occur when phosphates and nitrates are low. The last group (desmids) is poorly represented in the Nile. Blue greens show a correlation with increasing organic matter in the water. They can develop like colonial green algae when dissolved nitrates and phosphates are low.

5. The water as a whole is on the alkaline side. The data on pH determinations do not point towards the hydrogen ion as a limiting factor.

6. The oxygen is fairly uniformly distributed throughout the water of the river. There is no differentiation into a well oxygenated upper layer and a poorly oxygenated lower layer.

7. The temperature of the water follows the atmospheric temperature fairly closely.

8. The vertical distribution of temperature in the river is uniform. If there is any slight tendency to stratify light winds prevent actual stratification from taking place.

9. The distribution of light through the year is not so unequal as that of heat or water supply.

10. The depth to which 1% surface light penetrated varied from 0.07 metres during flood period and 2.2 metres during low stage.

ERIK G. JØRGENSEN, Diatom Communities in some Danish Lakes and Ponds. Det Kong. Danske Vid. Selsk., Biol. Skrifter, V, No. 2, 1948, 140 p., 4 fig., 3 plates.

Condensed Summary. — 1. Comparison between the diatom communities in some Danish lakes and ponds shows, following the writer, a repetition of various diatom sociations from one locality to another.

2. A summary of localities is given with the usual details.

3. Of milieu factors pH, color, KMnO_4 consumption, alkalinity and total hardness were examined, with sometimes a comparison between the hardness.

4. A tentative classification into lake and pond types is given. There seems to be a smaller number of species in dystrophic localities than in clear-water ones; otherwise, there is not much difference between them. Acidotrophic localities contain acidobiontic and acidophilous species almost exclusively; the sociation there found on the sandy bottom occurs again in several of the harmoniously oligotrophic lakes, with addition of some indifferent and alkaliphilous species.

5. Of the later lake type, the largest, Hampen Sø, while closely related to the other, shows points of resemblance with the surf zone of the eutrophic lakes. Some of the harmoniously oligotrophic ponds have on the sandy bottom near their banks, *Neidium* species and *Surirella birostrata* together with species found in the acidotrophic ponds. The others, including all acid dune lakes, have a sociation of their own. Epiphyte samples also have different contents.

6. In the eutrophic localities the vegetation consists of alkalibiontic and alkaliphilous species together with some indifferent ones. On the bottom near the shore and on stones in the surf zone a sociation is found with the character species *Amphora ovalis* v. *pediculus*; on the *Cladophora* vegetation in the same zone another, slightly different sociation is found; this is further the case with higher plants in the surf zone and with quiet waters. In the smaller lakes the sociations of the surf zone are less typically developed; their communities form a distinct transition to the ponds; characteristic is the abundance of *Cymbella* species.

7. *Cocconeis placentula* and *Fragillaria* species, dominating in the bottom samples of the ponds, must be regarded as sedimentary forms; while where the bottom consists of fallen leaves, some *Navicula* seem to be particularly frequent. *Achnantes hungarica* and *Cocconeis placentula* characterize a sociation on *Lemna* species. In the higher plants the vegetation is particularly abundant in *Cocc. placentula* and *Eunotia arcus*, sometimes with some *Epithemia*, *Eunotia arcus* and *gracilis*, while frequent in ponds, were found in only small numbers in lakes; this was also the case of most *Gomphonema* species.

8. Samples from a few localities were taken at different times on the year; this enabled the writer to show that different diatoms have their maximum at different seasons. The bulk of samples analyzed represent, apart from certain spring samples, the aestival aspect of the sociations.

9. The quantitative diatom values on various substrates are referred to in one section of the paper.

10. The author cannot accept the term halophobe, as the NaCl content in acidotrophic lakes and ponds need not be lower than in eutrophic lakes and ponds. He further expresses doubt that there are diatoms associated exclusively with *Sphagnum*.

11. According to their occurrence at different pH values the diatoms can be divided into 5 groups: acidobiontic, acidophilous, indifferent, alkaliphilous and alkalibiontic.

12. A brief summary is given of the commoner diatom sociations.

13. Four new or imperfectly known species and one variety are described: *Caloneis digitus*, *Navicula leptostriata*, *N. lobelliae*, *N. madumensis* and *Melosira distans* v. *perglabra*.

A. REIJNE, Over de jaarlijkse aanwas van organisch sediment in door dijkbreuk gevormde kolken. Verh. Kon. Ned. Ak. Wet., afd. Natuurkunde, 2e sectie, XLV, No. 3, 1948, 72 p., 3 fig.

Condensed English Summary. — On the yearly accress of organic sediment in pools, formed by dike-burst. The writer examined 12 pools formed in 1717 by burst of the IJ-dikes, and by some other dike-bursts (1543-1825). Most of them have a hard sand bottom, so that the depth of the mud deposited since their origin could be measured by means of an iron rod.

The organic mud in these pools is almost wholly formed by plankton, with a little sand or clay washed out from the walls of the pool in the first stage of sedimentation, in all about 10% of the total quantity of the sediment; for pools with brackish water which form the majority of the pools examined, a yearly accress of 15 mm of organic mud can be considered as a good average.

With one exception, these pools have an area not exceeding $2\frac{1}{2}$ acres so that disturbance by wind action is insignificant; besides, there has been no disturbance by the action of man (except in one case) which has permitted a quiet sedimentation. The mud deposits examined had a thickness of 2.6—7 m.

This mud is soft, black and generally smells of sulphuretted hydrogen; in drying, it shrinks to $1/6$ — $1/15$ of its original volume and becomes light gray, hard and elastic, and cannot be reduced to its former state. But in its natural state the mud shrinks only to a slight extent, the superficial layers become solid and protect those below.

The mud consists largely of amorphous organic matter, so that very little is revealed by microscopical investigation as to the original components of the mud; only a few siliceous, chitinous and cuticular remains can be identified. A monthly survey of some of the pools showed that during spring there is a considerable development of diatoms and during fall of flagellates. The maxima observed were (plankton in cc per m³ of water): *Cyclotella meneghiniana* Kütz 688, *Stephanodiscus hantzschii* Grün 134, *Gymnodinium mirabile* Pénard (var.) 402, *Cryptomonas erosa* Ehrb. 120, *Brachionus mülleri* Ehrb. 300. The mud is largely formed by microphytes, only in 20% of the observations the animal plankton was predominant.

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Dr. W. Junk, publishers - The Hague

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